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THE VETERINARY JOURNAL

A MONTHLY REVIEW OF VETERINARY SCIENCE

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The Veterinary Journal

FEBRUARY, 1947

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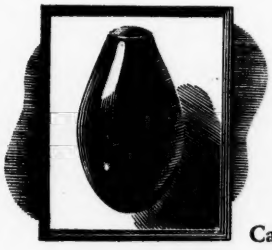

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THE VETERINARY JOURNAL

Vol. 103 February, 1947 No. 2

EDITORIAL

CONTROL OF CONTAGIOUS DISEASES

METHODS for the control of contagious diseases vary in different countries, and sometimes criticism is levelled at the attitude of those responsible for their operation. There arises periodically, in the minds of the public, questions on the necessity for the persistence in the application of the measures laid down, and it seems to be thought by some that some of the measures could be relaxed, or that the policy in operation could be altered. In these connections recent attention has been drawn to rabies and foot-and-mouth disease.

The two dogs infected with rabies while in quarantine which have been reported during the past few weeks are examples of the value of the quarantine method of controlling that disease, and so preventing its spread in this country. After freedom from rabies in Great Britain for a number of years, a dog in quarantine, introduced from Italy on October 31, showed symptoms of the dumb form of rabies on November 25, and died within three days: pathological examination confirmed the existence of rabies. Within a few weeks a second dog, also in quarantine, was found to be suffering from the disease: it arrived from India on December 12 and became ill on January 9, and died within three days. The two cases were quite unrelated. These instances illustrate the value of, and the necessity for, the adoption of the quarantine system now being practised. Many of our readers will recall the extensive outbreak of rabies in this country soon after the 1914-18 war: those responsible for the control of this disease are to be congratulated on the position to-day, especially following the risks of the introduction of the disease within the past few years.

FUEL CRISIS

Owing to the fuel and power crisis it may not be possible to publish the March issue of monthly journals. If, therefore, readers do not receive their copies of the *Veterinary Journal* it will be due to the Government stopping publication to conserve fuel.

When outbreaks of foot-and-mouth disease attract public attention, the question invariably raised is whether the slaughter policy as carried out in this country is the most satisfactory method of controlling the disease, or whether it should give place to other methods, e.g., vaccination, as carried out in some countries. There can be little doubt that the slaughter policy is the surest method at the present time, and it is reassuring to read that, in answer to a recent question in Parliament, the Minister of Agriculture and Fisheries stated that he was "satisfied that the slaughter policy to eradicate foot-and-mouth disease is by far the best, and that no other known method would have been so successful in preventing the spread of the disease."

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GENERAL ARTICLES

OBSERVATIONS ON SOME METABOLIC DISORDERS OF COWS AS EVIDENCED BY CHEMICAL ANALYSIS OF SAMPLES OF BLOOD FROM CLINICAL CASES

(2) Some Aspects of Blood Chemistry

By W. M. ALLCROFT

Ministry of Agriculture, Veterinary Laboratory, Weybridge

Introduction

In extension of the first part of this paper (Allcroft, 1947 [i]), the chemical relationships of the various disorders have been investigated. The constituents of the blood which are considered, separately and in relation to each other, are calcium, magnesium and acetone bodies of the serum, and sugar and inorganic phosphorus of the whole blood. Comparable studies of the hæmoglobin have already been published (Allcroft, 1941).

The Normal Range of Constituents

As a basis for consideration of the data for clinical cases, it was necessary to postulate what were considered to be the normal physiological range of variation of each of the constituents in the blood of the cow. These physiological ranges were determined from the chemical data obtained from analyses from a reasonably large number of animals which were in good condition and showed no symptoms of any clinical disorder.

The relevant percentage distribution of the actual values found within the physiological range are shown in the same histogram form as is used throughout the consideration of the clinical material, Fig. 1. These charts form the base line for comparison of the changes occurring in clinical conditions, and also indicate the probability of any value occurring in the normal range.

The following were the normal ranges and distributions:—

Serum calcium.—The range was 8.5 to 11.4 mg. p.c., but 68 per cent. of the values were in the smaller range, 9.5 to 10.4 mg. p.c., with the remaining 32 per cent. almost equally divided over the upper and lower ends of the full range.

Serum magnesium.—The range was 1.8 to 3.2 mg. p.c., and of these 55 per cent. were between 1.8 and 2.4 mg. p.c., and 45 per cent. between 2.5 and 3.2 mg. p.c.

Blood sugar.—The range, based only on observations when the animal was not noticeably disturbed or excited in the process of restraint for sampling, was 41 to 70 mg. p.c., 46 per cent. of values were between 51 and 60 mg. p.c., and the remaining 54 per cent. were fairly equally divided over the upper and lower ends of the full range.

Blood inorganic phosphorus.—The normal range was 3.1 to 6.0 mg. p.c., and the distribution over the intermediate subdivisions 3.1 to 4.0 and 4.1 to 5.0 and 5.1 to 6.0 mg. p.c. was almost the same as for blood sugar.

Serum acetone bodies.—These are not charted, but any value up to 10 mg. p.c. was considered normal, and the biochemical classification of acetonæmia, as distinct

from the clinical estimation, is 10.1 to 20 mg. p.c. as mild and 20.1 mg. p.c. and above as marked acetonæmia. The relationship between blood values and severity of clinical symptoms is not a very precise one.

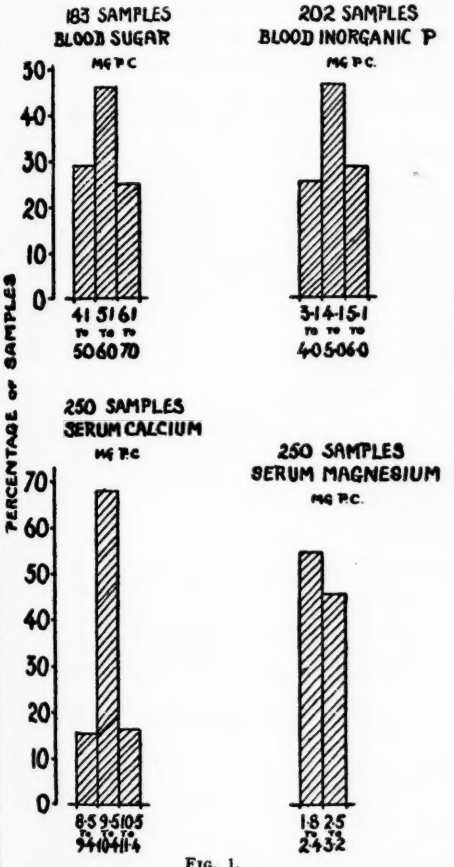


FIG. 1.
Histogram presentation of percentage distribution of values for serum calcium, serum magnesium, blood sugar and inorganic P in the physiological range for cows.

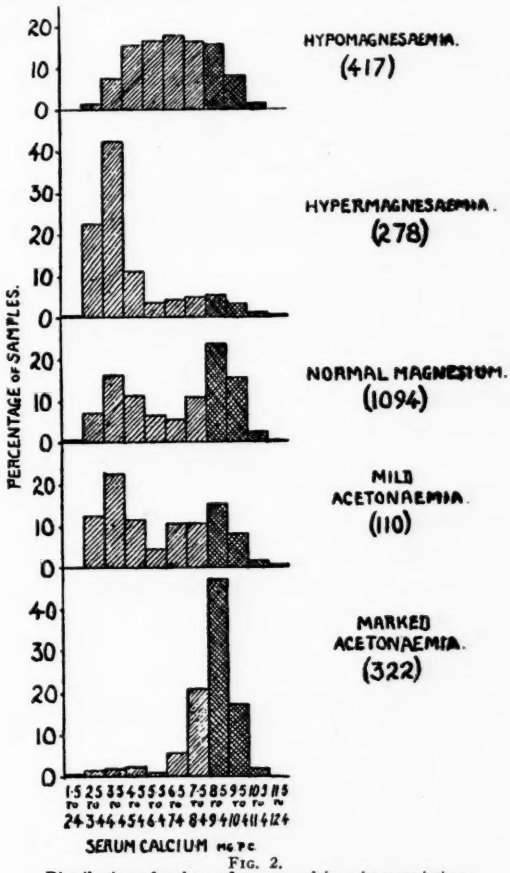


FIG. 2.
Distribution of values of serum calcium in association with other biochemical features. The double-hatched area shows the normal range. The numbers in brackets show the total number of samples.

Chemical Considerations in Metabolic Disorders

Each of the four constituents—calcium, magnesium, sugar and inorganic phosphorus—will be considered in relation to the biochemical typing of the disorders as outlined in the first part of this paper (Allcroft, 1947 [i]).

(1) *Serum Calcium in Metabolic Disorders*

The data for the distribution of values of serum calcium in the various disorders, as associated with other chemical features, are presented in Table I and Fig. 2, while Table II and Fig. 3 show the total and percentage distribution of the hypocalcæmic values in each disorder.

TABLE I

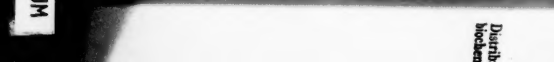
Association of Certain Biochemical Features with the Level of Serum Calcium

Serum Calcium mg. p.c.	Actual number of samples: Marked Acetonæmia	Mild Acetonæmia	Normal Magnesium	Hypermagnesæmia	Hypomagnesæmia	Percentage distribution of samples: Marked Acetonæmia	Mild Acetonæmia	Normal Magnesium	Hypermagnesæmia	Hypomagnesæmia
1.5 to 2.4	1		7	1		0.3		0.6	0.4	
2.5 to 3.4	5	14	78	62	6	1.5	12.7	7.1	22.3	1.4
3.5 to 4.4	6	25	176	117	32	1.9	22.7	16.1	42.2	7.7
4.5 to 5.4	7	13	124	31	66	2.2	11.8	11.3	11.1	15.8
5.5 to 6.4	3	5	70	12	70	0.9	4.5	6.4	4.3	16.8
6.5 to 7.4	18	12	59	11	75	5.6	10.9	5.4	3.9	18.0
7.5 to 8.4	68	12	119	14	65	21.1	10.9	10.9	5.0	15.6
8.5 to 9.4	152	17	260	15	62	47.2	15.5	23.8	5.4	14.9
9.5 to 10.4	56	9	172	10	35	17.4	8.2	15.7	3.6	8.4
10.5 to 11.4	6	2	26	3	6	1.9	1.9	2.4	1.1	1.4
11.5 to 12.4		1	3	2			0.9	0.2	0.7	
Total	322	110	1,094	278	417	100.0	100.0	100.0	100.0	100.0

TABLE II

Association of Certain Biochemical Features with Degree of Hypocalcæmia

Serum Calcium mg. p.c.	Actual number of samples: Mild Acetonæmia	Normal Magnesium	Hypermagnesæmia	Hypomagnesæmia	Percentage distribution of samples: Mild Acetonæmia	Normal Magnesium	Hypermagnesæmia	Hypomagnesæmia
1.5 to 2.4		7	1			1.1	0.4	
2.5 to 3.4	14	78	62	6	17.3	12.3	25.0	1.9
3.5 to 4.4	25	176	117	32	30.9	27.8	47.2	10.2
4.5 to 5.4	13	124	31	66	16.0	19.6	12.5	21.0
5.5 to 6.4	5	70	12	70	6.2	11.1	4.8	22.3
6.5 to 7.4	12	59	11	75	14.8	9.3	4.4	23.9
7.5 to 8.4	12	119	14	65	14.8	18.8	5.7	20.7
Total	81	633	248	314	100.0	100.0	100.0	100.0



In acetonæmia there was a difference in the serum calcium distribution according to the level of acetone bodies. In marked acetonæmia the serum calcium was either subnormal or in the lower part of the physiological range. 68.3 per cent. showed values between 7.5 and 9.4 mg. p.c., 19.3 per cent. between 9.5 and 11.4 mg. p.c., and only 12.5 per cent. were below 7.5 mg. p.c. In mild acetonæmia the distribution was 26.4 per cent. between 7.5 and 9.4 mg. p.c., 11.1 per cent. between 9.5 and 11.4 mg. p.c., and 62.5 per cent. below 7.5 mg. p.c.

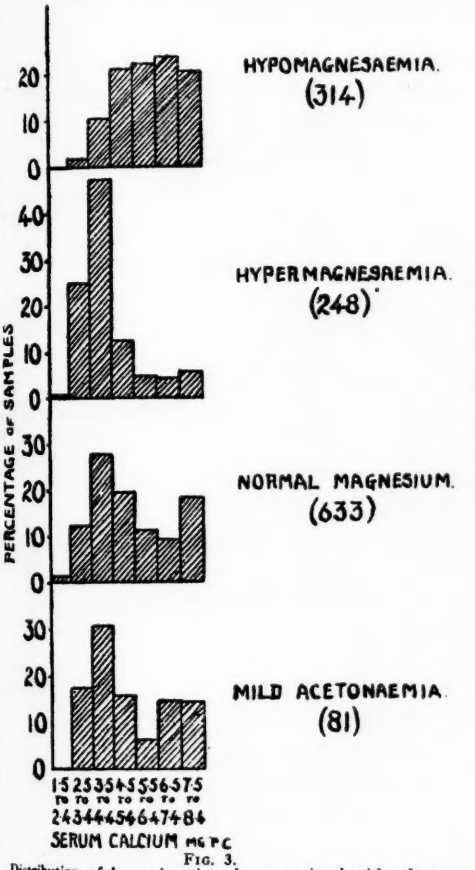


FIG. 3.
Distribution of hypocalcæmic values associated with other biochemical features. The numbers in brackets show the total number of samples.

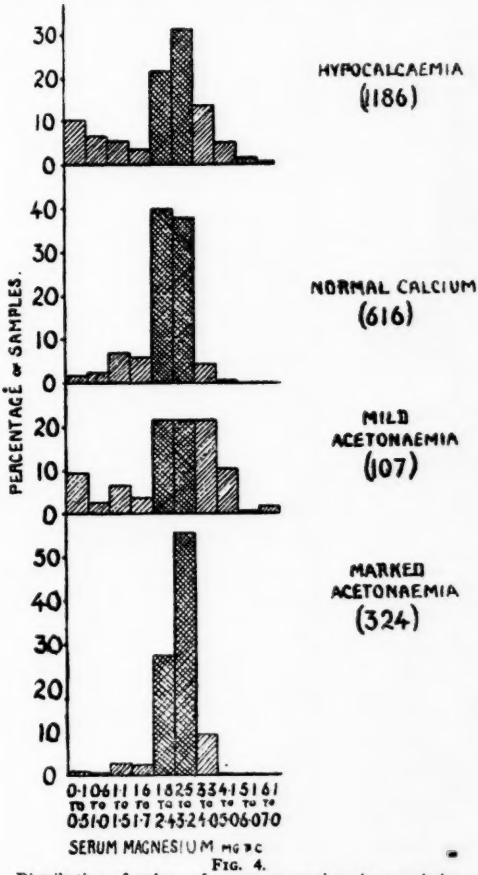


FIG. 4.
Distribution of values of serum magnesium in association with other biochemical features. The double-hatched area shows the normal range. The numbers in brackets show the total number of samples.

Of the 81 cases associated with hypocalcæmia, 64.2 per cent. were below 5.5 mg. p.c.

These observations on mild acetonæmia serve to emphasise the association of this condition, which is seldom clinically recognised, with the occurrence of milk fever in the puerperium.

When the serum magnesium was normal, 41.9 per cent. of the samples also showed normal calcium values. Of the hypocalcæmic values, 41.2 per cent. were below 4.5 mg. p.c. and 60.8 per cent. were below 5.5 mg. p.c. When the serum

magnesium was above normal, i.e., 3.3 mg. p.c. and above, only 10.8 per cent. of the calcium values were normal, while 64.5 per cent. were below 4.5 mg. p.c. Of the hypocalcæmic values, 72.6 per cent. were below 4.5 mg. p.c. and 85.1 per cent. below 5.5 mg. p.c. These observations confirm the frequent association of hypermagnesæmia with the hypocalcæmia of milk fever and are interesting in view of the tendency for serum magnesium to rise in normal calvings (Allcroft and Godden, 1934).

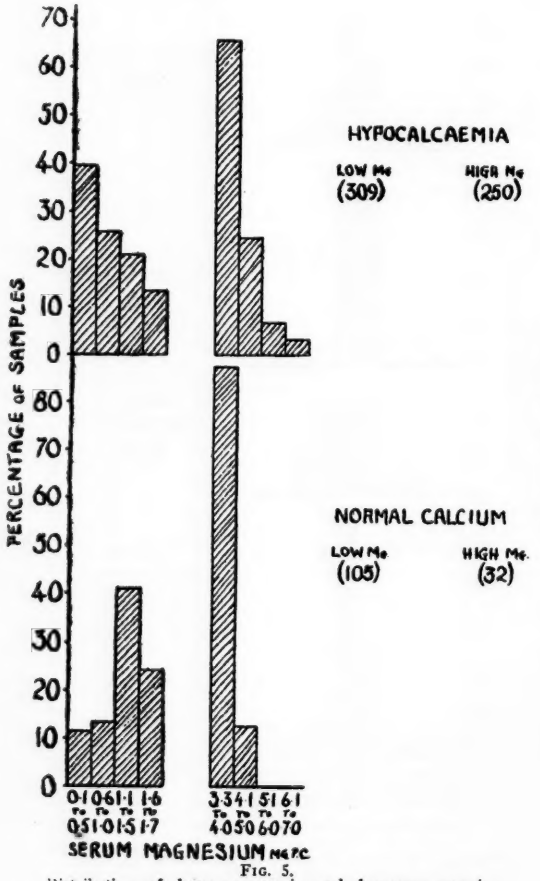


FIG. 5.
Distribution of hypomagnesæmic and hypermagnesæmic values in association with other biochemical features. The numbers in brackets show the total number of samples.

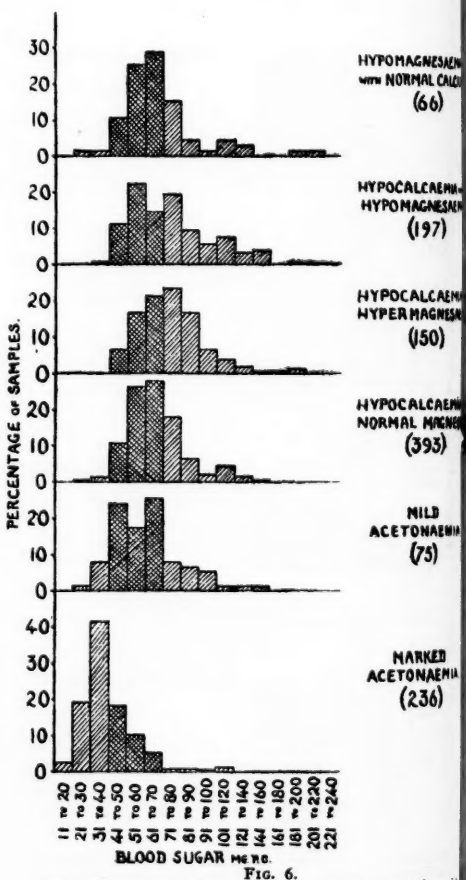


FIG. 6.
Distribution of values of blood sugar in association with other biochemical features. The double-hatched area shows the normal range. The numbers in brackets show the total number of samples.

When hypomagnesæmia was present, 24.7 per cent. of the calcium values were normal and 75.3 per cent. were below the physiological range. Of the hypocalcæmic-hypomagnesæmic cases, 87.9 per cent. were fairly evenly spread over the range 4.5 to 8.4 mg. p.c., and only a few were below the 4.5 mg. p.c. level. These observations are interesting and at least suggest that the clinical disorder with hypomagnesæmia is recognisable when the calcium is less markedly

TABLE III
ASSOCIATION OF CERTAIN BIOCHEMICAL FEATURES WITH THE LEVEL OF SERUM MAGNESIUM
ACTUAL NUMBER OF SAMPLES
PERCENTAGE DISTRIBUTION OF SAMPLES

TABLE III

ASSOCIATION OF CERTAIN BIOCHEMICAL FEATURES WITH THE LEVEL OF SERUM MAGNESIUM

Serum Magnesium mg. p.c.	ACTUAL NUMBER OF SAMPLES: Marked Acetonæmia	Mild Acetonæmia	Normal Calcium	Hypo-calcæmia	PERCENTAGE DISTRIBUTION OF SAMPLES: Marked Acetonæmia	Mild Acetonæmia	Normal Calcium	Hypo-calcæmia
0.1 to 0.5	3	10	12	122	0.9	9.4	1.9	10.3
0.6 to 1.0	2	3	14	80	0.6	2.8	2.3	6.7
1.1 to 1.5	9	7	43	65	2.8	6.6	7.0	5.5
1.6 to 1.7	8	4	36	42	2.5	3.7	5.8	3.6
1.8 to 2.4	89	23	245	257	27.5	21.5	39.9	21.7
2.5 to 3.2	180	23	234	370	55.5	21.5	38.0	31.2
3.3 to 4.0	30	23	28	164	9.3	21.5	4.5	13.8
4.1 to 5.0	1	11	4	61	0.3	10.2	0.6	5.1
5.1 to 6.0	1	1		17	0.3	0.9		1.4
6.1 to 7.0	1	2		8	0.3	1.9		0.7
TOTAL	324	107	616	1,186	100.0	100.0	100.0	100.0

TABLE IV

ASSOCIATION OF CERTAIN BIOCHEMICAL FEATURES WITH THE DEGREE OF HYPO OR HYPERMAGNESÆMIA

Serum Magnesium mg. p.c.	ACTUAL NUMBER OF SAMPLES: Marked Acetonæmia	Mild Acetonæmia	Normal Calcium	Hypo-calcæmia	PERCENTAGE DISTRIBUTION OF SAMPLES: Normal Calcium	Hypo-calcæmia
0.1 to 0.5 ...	3	10	12	122	11.4	39.6
0.6 to 1.0 ...	2	3	14	80	13.3	25.8
1.1 to 1.5 ...	9	7	43	65	41.0	21.0
1.6 to 1.7 ...	8	4	36	42	34.3	13.6
TOTAL ...	22	24	105	309	100.0	100.0
3.3 to 4.0 ...	30	23	28	164	87.5	65.6
4.1 to 5.0 ...	1	11	4	61	12.5	24.4
5.1 to 6.0 ...	1	1		17		6.8
6.1 to 7.0 ...	1	2		8		3.2
TOTAL ...	33	37	32	250	100.0	100.0

reduced than if the magnesium is normal or high. As these mixed cases occasion the practitioner some considerable trouble in diagnosis, and very many of them respond successfully to calcium therapy alone, the probability is that the hypomagnesæmia is incidental, and may even have little significance, as being of the seasonal type without symptoms reported by Allcroft and Green (1938) and Allcroft (1947 [iii]). It would appear to depend on the rate at which the serum magnesium has previously fallen: if the fall has been slow and steady, the low value may perhaps have little clinical significance for therapeutic measures though it does complicate the symptomatology of the case.

(2) *Serum Magnesium in Metabolic Disorders*

The data for serum magnesium distribution in association with other biochemical features are shown in Table III and Fig. 4, while Table IV and Fig. 5 show the respective percentage distribution of the hypomagnesæmic and hypermagnesæmic values in each case.

In marked acetonæmia, 83 per cent. of the values were normal, with a tendency towards the upper half of the physiological range, though the extremes of values recorded were 0.2 and 6.8 mg. p.c.

In mild acetonæmia, 43.0 per cent. of the values were normal, 34.5 per cent. were above 3.2 mg. p.c. and 22.5 per cent. below 1.8 mg. p.c.

When serum calcium was normal, 77.9 per cent. of the magnesium values were also normal, 17.0 per cent. were above 3.2 mg. p.c. and only 5.1 per cent. below 1.8 mg. p.c. When serum calcium was low, 52.9 per cent. of magnesium values were normal, 21.0 per cent. were high and 26.1 per cent. were low.

Study of Table IV and Fig. 5 shows that the serum magnesium values were more widely scattered when serum calcium was low than when the calcium was normal, the deviation being both above and below the physiological range. With hypocalcæmia, the aberrant serum magnesium values were also more evenly distributed on each side of the normal. These data again stress the association of hypermagnesæmia and hypocalcæmia. Of the hypomagnesæmic values, it is seen that the percentage distribution of very low values, i.e., 1.0 mg. p.c. and below, varied with the level of serum calcium, being 24.7 per cent. when calcium was normal and 65.4 per cent. when the calcium was low.

(3) *Blood Sugar in Metabolic Disorders*

The data for blood sugar are presented in Table V and Fig. 6.

In marked acetonæmia, often called post-parturient dyspepsia, 63.2 per cent. of blood sugar values were low. Of the 33.6 per cent. which show normal blood sugar levels, there was a strong bias toward the lower end of the physiological range, since 54.5 per cent. were between 41 and 50 mg. p.c. compared with 29 per cent. normal expectation (see Fig. 1). Only 3.2 per cent. showed hyperglycæmia, though values as high as 116 mg. p.c. were recorded. In mild acetonæmia, already shown to be commonly associated with hypocalcæmic conditions, 66.7 per cent. of the values were normal, 23.9 per cent. showed hyperglycæmia and only 9.3 per cent. showed hypoglycæmia.

These observations show the tendency for acetonæmia to be associated with hypoglycæmia, though it is clear that normal and even high sugar values may easily be found in this condition.

TABLE V

Association of Certain Biochemical Features with the Level of Blood Sugar

Blood Sugar mg. p.c.	Actual number of samples						Percentage distribution of samples					
	Marked Aceto-næmia	Mild Aceto-næmia	Hypo-calcæmia with normal Magnesium	Hypo-cal-cæmia with Hyper-mag-nesæmia	Hypo-cal-cæmia with Hypo-mag-nesæmia	Hypo-mag-nesæmia with normal Calcium	Marked Aceto-næmia	Mild Aceto-næmia	Hypo-calcæmia with normal Magnesium	Hypo-cal-cæmia with Hyper-mag-nesæmia	Hypo-cal-cæmia with Hypo-mag-nesæmia	Hypo-mag-nesæmia with normal Calcium
11 to 20 ...	6					...	2.5					
21 „ 30 ...	45	1	2			1 ...	19.2	1.3	0.5			1.5
31 „ 40 ...	98	6	5		2	1 ...	41.5	8.0	1.3		1.0	1.5
41 „ 50 ...	43	18	43	10	22	7 ...	18.3	24.0	10.8	6.7	11.1	10.6
51 „ 60 ...	24	13	103	25	44	17 ...	10.2	17.3	26.2	16.7	22.3	25.3
61 „ 70 ...	12	19	110	32	29	19 ...	5.1	25.4	28.0	21.3	14.8	28.9
71 „ 80 ...	2	6	71	35	38	10 ...	0.8	8.0	18.0	23.3	19.4	15.2
81 „ 90 ...	2	5	25	25	19	3 ...	0.8	6.7	6.4	16.7	9.7	4.5
91 „ 100 ...	1	4	8	10	11	1 ...	0.4	5.3	2.0	6.7	5.6	1.5
101 „ 120 ...	3	1	17	6	15	3 ...	1.2	1.3	4.3	4.0	7.6	4.5
121 „ 140 ...		1	6	3	7	2 ...		1.3	1.5	2.0	3.5	3.0
141 „ 160 ...		1	3	1	8	...		1.3	0.8	0.7	4.0	
161 „ 180 ...				1		...				0.7		
181 „ 200 ...				2	1	1 ...				1.3	0.5	1.5
201 „ 220 ...						1 ...						1.5
221 „ 240 ...					1	...					0.5	
Total	236	75	393	150	197	66	100.0	100.0	100.0	100.0	100.0	100.0

In hypocalcæmia with normal serum magnesium, 65 per cent. of blood sugar values were normal, with a bias on the high side of the physiological range, since 43 per cent. were between 61 and 70 mg. p.c. compared to a normal expectation of 25 per cent. (see Fig. 1). Only 1.8 per cent. showed hypoglycæmia and the remaining 33.2 per cent. showed quite marked hyperglycæmia. In hypocalcæmia

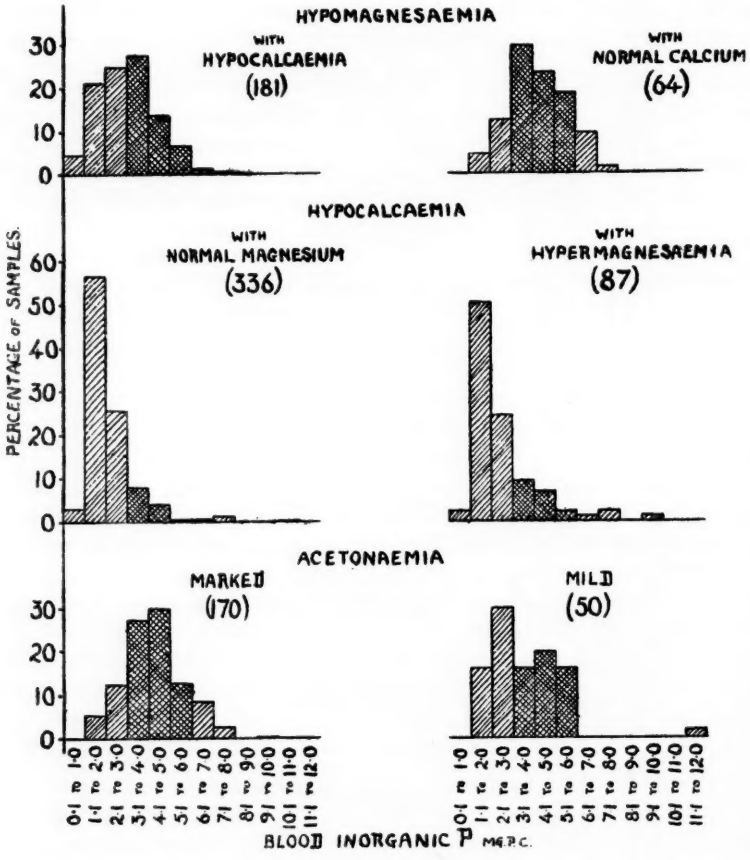

HYPOMAGNESAEMIA
WITH HYPOCALCAEMIA (181)
WITH NORMAL CALCIUM (64)
HYPOCALCAEMIA
WITH NORMAL MAGNESIUM (336)
WITH HYPERMAGNESAEMIA (87)
ACETONAEMIA
MARKED (170)
MILD (50)
PERCENTAGE OF SAMPLES
0 10 20 30 40 50 60
0-1 1-1 2-1 3-1 4-1 5-1 6-1 7-1 8-1 9-1 10-1 11-1
1-0 2-0 3-0 4-0 5-0 6-0 7-0 8-0 9-0 10-0 11-0 12-0
BLOOD INORGANIC P MG.P.C.

FIG. 7.
Distribution of values of inorganic P in association with other biochemical features. The double-hatched areas show the normal range. The numbers in brackets show the total number of samples.

with hypermagnesæmia, 44.7 per cent. of blood sugar values were normal, with a high bias in the normal range, and all the remainder showed hyperglycæmia.

These data indicate an association between hyperglycæmia and hypermagnesæmia, and are interesting in view of the observations made where injections of magnesium sulphate were made in goats (Allcroft, 1947 [iv]), and marked hyperglycæmia was produced.

In cases of hypomagnesæmia with normal calcium, 64.8 per cent. of blood sugar values were normal, with a high bias in the normal range, and the remainder

TABLE VI

ASSOCIATION OF CERTAIN BIOCHEMICAL FEATURES WITH THE LEVEL OF BLOOD INORGANIC P.

Blood Inorganic P. mg. p.c.	ACTUAL NUMBER OF SAMPLES						PERCENTAGE DISTRIBUTION OF SAMPLES					
	Marked Aceto-næmia	Mild Aceto-næmia	Hypo-calcæmia with normal Magnesium	Hypo-cal-cæmia with Hyper-mag-nesæmia	Hypo-cal-cæmia with Hypo-mag-nesæmia	Hypo-mag-nesæmia with normal Calcium	Marked Aceto-næmia	Mild Aceto-næmia	Hypo-calcæmia with normal Magnesium	Hypo-cal-cæmia with Hyper-mag-nesæmia	Hypo-cal-cæmia with Hypo-mag-nesæmia	Hypo-mag-nesæmia with normal Calcium
0.1 to 1.0 ...			10	2	8	...			3.0	2.3	4.4	
1.1 „ 2.0 ...	9	8	190	44	38	3 ...	5.3	16.0	56.6	50.2	21.0	4.7
2.1 „ 3.0 ...	21	15	86	21	45	8 ...	12.3	30.0	25.6	24.3	24.9	12.5
3.1 „ 4.0 ...	46	8	27	8	50	19 ...	27.2	16.0	8.0	9.3	27.6	29.7
4.1 „ 5.0 ...	51	10	14	6	25	15 ...	30.0	20.0	4.1	6.9	13.8	23.4
5.1 „ 6.0 ...	22	8	2	2	12	12 ...	12.9	16.0	0.6	2.3	6.6	18.7
6.1 „ 7.0 ...	15		2	1	2	6 ...	8.8		0.6	1.2	1.1	9.4
7.1 „ 8.0 ...	5		4	2	1	1 ...	2.9		1.2	2.3	0.6	1.6
8.1 „ 9.0 ...						...						
9.1 „ 10.0 ...	1			1		...	0.6			1.2		
10.1 „ 11.0 ...			1			...			0.3			
11.1 „ 12.0 ...		1				...		2.0				
TOTAL	170	50	336	87	181	64	100.0	100.0	100.0	100.0	100.0	100.0

were definitely high. When both calcium and magnesium were low, 48.2 per cent. of blood sugar values were normal, 50.3 were high and 1.0 per cent. were low.

In assessing the values for blood sugar, the factor of disturbance and excitement is important to remember. Though there is association of hyperglycæmia with hypocalcæmia, there is a stronger association with hypomagnesæmia where excitability is a common feature. Except in acetonæmia, it is doubtful if the blood sugar changes are of much importance.

(4) *Inorganic Phosphorus in Metabolic Disorders*

The data for blood inorganic phosphorus are presented in Table VI and Fig. 7.

Associated with marked acetonæmia, 70.1 per cent. of values were normal, 17.6 per cent. were low and 22.3 per cent. were high. When the acetonæmia was mild, a condition already seen to be frequently associated with hypocalcæmic conditions, 52.0 per cent. of values were normal, 46.0 per cent. were low and 2.0 per cent. were very high.

In hypocalcæmic cases with normal magnesium, 85.2 per cent. of inorganic phosphorus values were low, 12.7 per cent. were normal and 2.1 per cent. were high. If the serum magnesium was high with hypocalcæmia, 76.8 per cent. of values were low, 18.5 per cent. were normal and 4.7 per cent. were high.

These observations stress the association of low inorganic phosphorus and hypocalcæmia with milk fever type of disorder. This association has been observed by many workers, though its significance is not yet known. It is a pathological exaggeration of the normal changes at calving, but seems to be rectified very shortly after satisfactory response to calcium therapy.

In hypomagnesæmic cases the distribution of inorganic phosphorus values varied with the calcium level. When calcium was normal, 17.2 per cent. of values were low, 71.8 per cent. were normal and 11.0 per cent. were high, but if the calcium was also lowered, 50.3 per cent. of values were low, 48.0 per cent. were normal and 1.7 per cent. were high.

The association of low inorganic phosphorus and hypocalcæmia was thus not so marked when hypomagnesæmia was also present.

Inter-relationship Between Certain Blood Constituents in Metabolic Disorders

The above observations have indicated certain associations between the levels of various constituents. In order to assess the degree of association, the constituents were plotted in pairs, on the spot chart principle, where each mark indicates a single case in respect of the two constituents under consideration. In all, 10 such charts were prepared, but only the most important are included below.

(1) *Serum Calcium and Magnesium*

These two elements are frequently discussed in relation to each other and stress has sometimes been laid on a Ca. : Mg. ratio. Fig. 8 shows the available data for calcium and magnesium.

In Fig. 8 cases are differentiated in accordance with the degree of acetonæmia present. It is evident that no association exists between the levels of the two

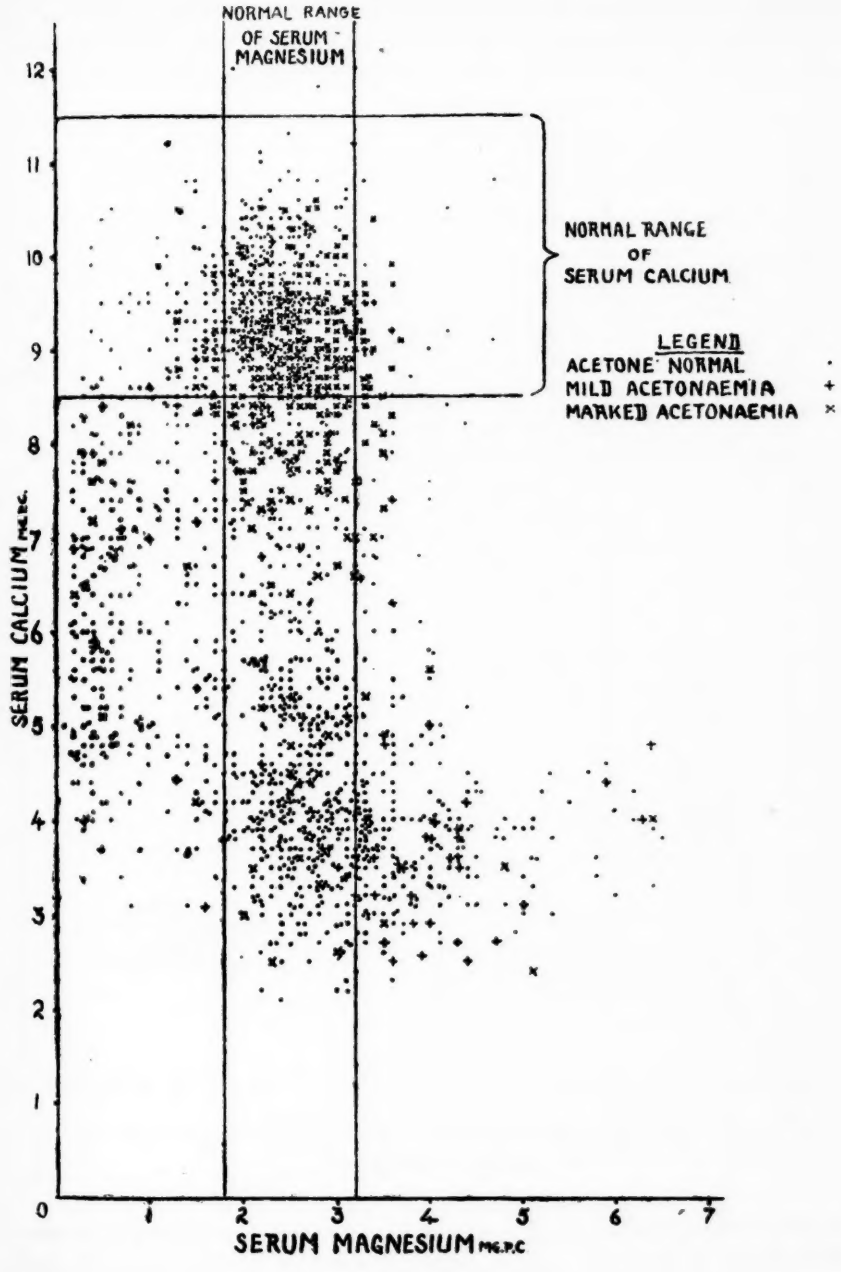


FIG. 8.

Spot chart of values for serum calcium and serum magnesium.

constituents, but that when the calcium level is lowered there is a widening of the range of concomitant serum magnesium values. This widening is due to the pronounced hypermagnesæmia which often accompanied milk fever type cases. The diversity of the Ca. : Mg. ratio is worthy of comment. The extreme ratios

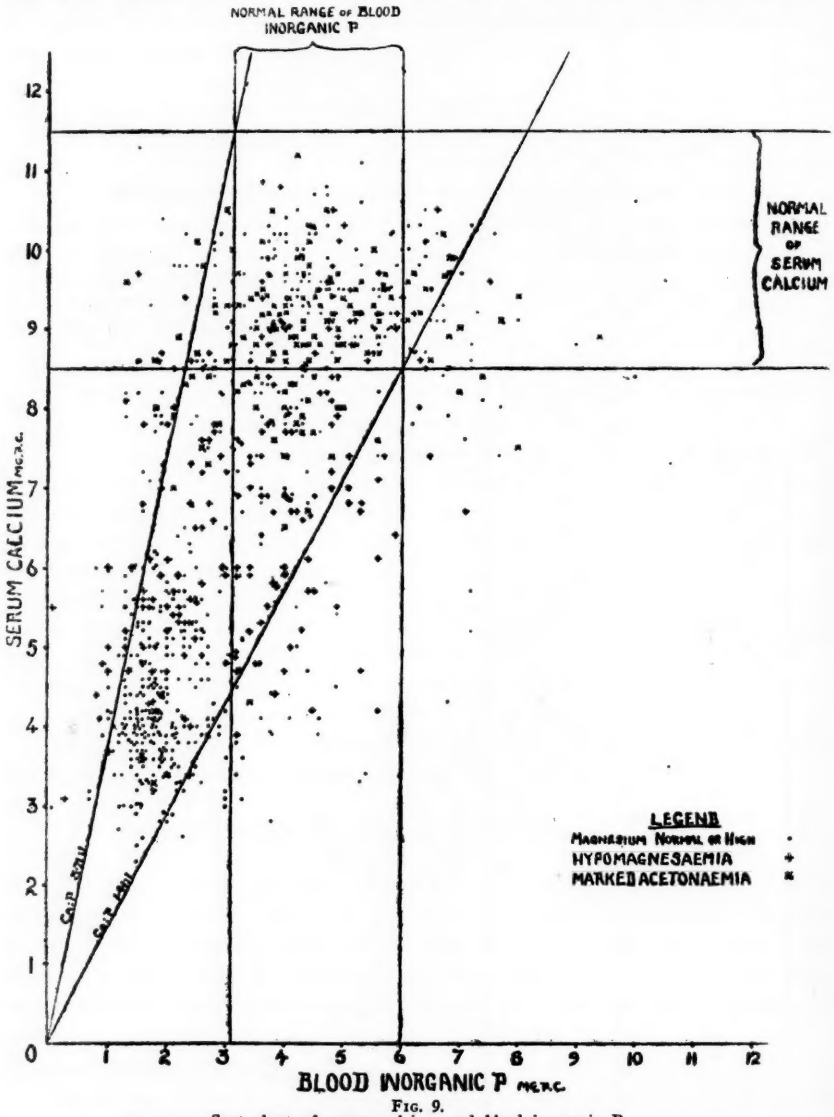


FIG. 9.
Spot chart of serum calcium and blood inorganic P.

in the postulated normal range is wide, 6.33 : 1 to 2.65 : 1, suggesting a considerable degree of flexibility, but in metabolic disorders it varies from 50 : 1 in hypomagnesæmia with normal calcium down to 0.47 : 1 in hypermagnesæmic milk fever.

(2) *Serum Calcium and Blood Inorganic Phosphorus*

The association between these two elements has been commented on above.

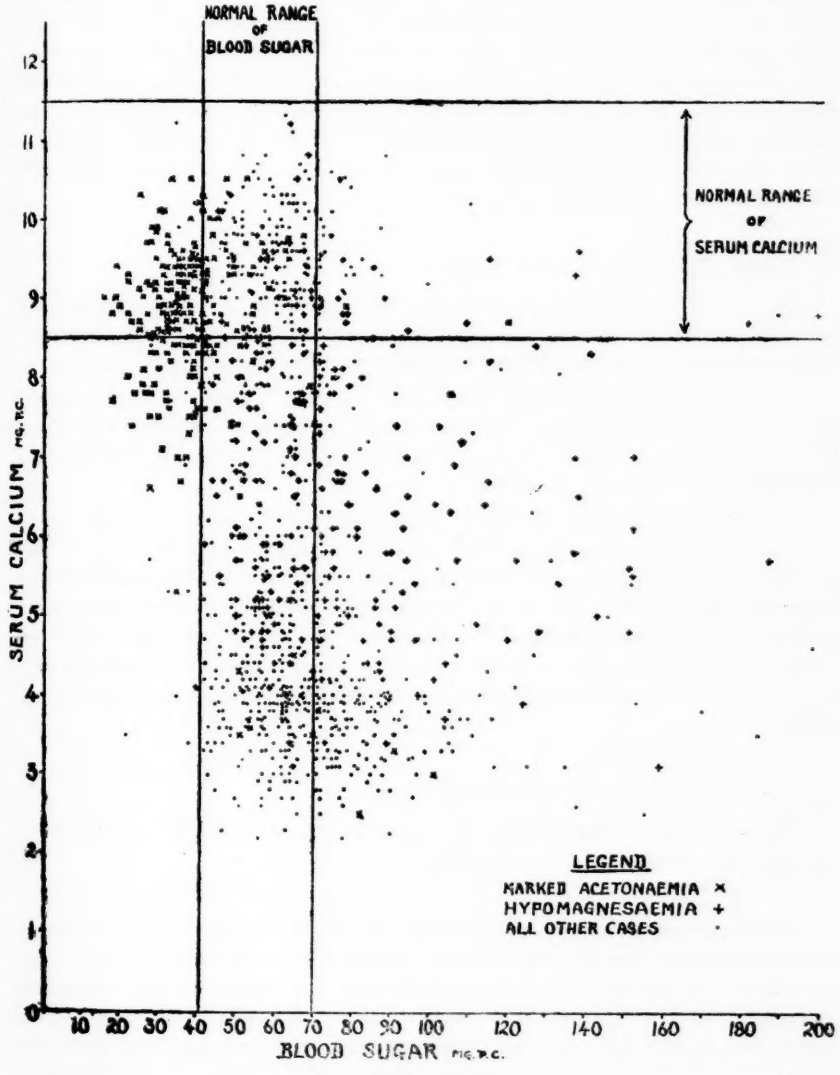

NORMAL RANGE OF BLOOD SUGAR
NORMAL RANGE OF SERUM CALCIUM
SERUM CALCIUM MG. P.C.
BLOOD SUGAR MG. P.C.
LEGEND
MARKED ACETONAEMIA ×
HYPOMAGNESAEMIA +
ALL OTHER CASES ·
0 1 2 3 4 5 6 7 8 9 10 11 12
10 20 30 40 50 60 70 80 90 100 120 140 160 180 200

FIG. 10.

Spot chart of serum calcium and blood sugar.

and the data, differentiated to show accompanying marked acetonæmia and hypomagnesæmia, are shown in Fig. 9.

This chart shows how well the association is established. The rectangle enclosing the normal ranges of the elements is enclosed in a sector bounded by radians representing Ca. : P. ratios of 3.7 : 1 and 1.41 : 1. Within this sector also are found most of the values in the hypocalcæmic range. The numbers of values in the normal calcium range which lie outside this sector are 19 wider ratios and 27 narrower ratios, while the corresponding numbers in the hypocalcæmic range are 50 and 79. Considering that there are 298 cases in the normal calcium range and 342 in the hypocalcæmic range, this association between hypocalcæmia and hypophosphatæmia is excellent. Of the hypocalcæmic values, in which the cases lie outside this sector, about one-third are associated with hypomagnesæmia and a few with acetonæmia.

(3) *Serum Calcium and Blood Sugar*

Some tendency to hyperglycæmia has been noted in the hypocalcæmic cases. The data for serum calcium and blood sugar are shown in Fig. 10, where concomitant hypomagnesæmia and acetonæmia are differentiated.

It is well recognised that the blood sugar is under nervous-endocrine control and that a variety of factors, such as muscular activity and emotional stimulus, will temporarily raise blood sugar. This renders the blood sugar level of little diagnostic value when it is raised.

Examination of Fig. 10 shows certain definite features. As the serum calcium level falls so there is a tendency for blood sugar level to increase. Above a calcium of 6.0 mg. p.c., most of the high blood sugar values are associated with hypomagnesæmic cases, but as the calcium level falls still further, the greater number of high values for sugar are associated with normal or high magnesium values, the milk fever type of case. This chart also shows that about one-third of the cases of marked acetonæmia are associated with some degree of hypocalcæmia.

(4) *Serum Acetone Bodies and Blood Sugar*

The data are shown in Fig. 11, which serves to stress the association of hypoglycæmia with marked acetonæmia.

With normal acetone levels, the bulk of the blood sugar values are normal and almost all the rest are high. When acetonæmia is mild there are fewer high and normal values and a reasonable number of low values. When acetonæmia is marked, most of the values are low or on the low side of the physiological range, though in a few cases very high values have been found associated with values of over 30 mg. p.c. for serum acetone bodies. There is no evidence of linear relation between the degree of acetonæmia and the degree of hypoglycæmia.

(5) *Blood Sugar and Blood Inorganic Phosphorus*

Fig. 12 shows the data and it is clear that there is no association between the two constituents.

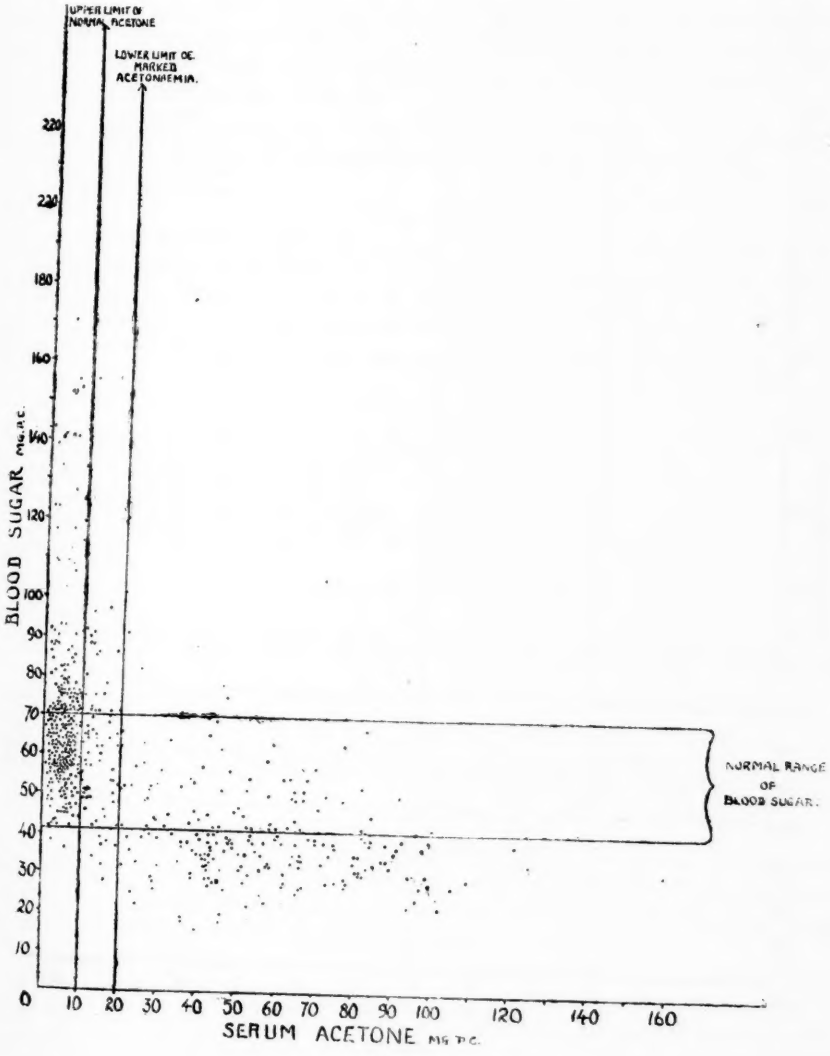


FIG. 11.

Spot chart of blood sugar and serum acetone.

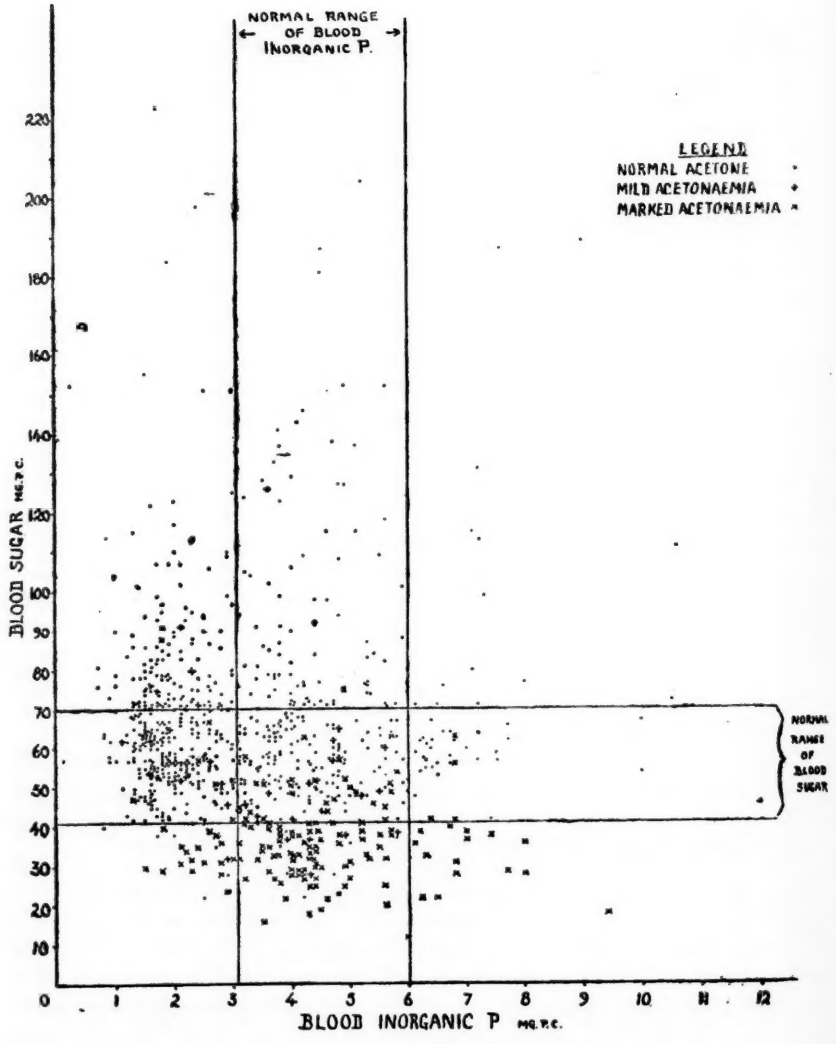


FIG. 12.

Spot chart of blood sugar and blood inorganic P.

Summary

Consideration of the blood chemistry of the cases reviewed in the first part of this paper revealed certain associations. Marked acetonæmia was largely associated with hypoglycæmia, but there was no linear relation between the degrees of deviation from normal.

Milk fever types of case, hypocalcæmia with normal or high magnesium values, showed general association with hyperglycæmia and low inorganic phosphorus values, though these features are not considered to be significant when considering therapeutic treatment.

Hypomagnesæmia was most commonly associated with hypocalcæmia, irrespective of the calcium level hyperglycæmia was generally observed.

Acknowledgments

I wish to acknowledge the continued interest of Dr. H. H. Green, head of the Biochemical Department, Weybridge, under whose direction the work was undertaken. To Dr. A. Eden and Messrs. F. J. Salt and C. W. Clarke I am indebted for many of the chemical determinations involved, carried out in connection with the general diagnostic work of the Biochemical Department.

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JOINT-ILL IN FOALS (PYOSEPTICÆMIA)

With Special Reference to the Prophylactic Treatment of the Foal at Birth

By O. V. GUNNING, D.V.M., M.R.C.V.S.

Introduction

A HIGHLY fatal disease of young foals, affecting the joints, has long been recognised as a menace to horse-breeding. As early as 1873, Bollinger showed it to be a disease arising from a primary seat of infection of the navel wound, which takes place at birth or very soon after.

In spite of this early discovery it is only within quite recent years that the nature of the disease has been understood. The modern conception of the disease is that of a septicæmia which may be caused by a number of distinct micro-organisms, each giving rise to a fairly consistent chain of symptoms ranging from a peracute form ending fatally in a few hours to a chronic form ending fatally after several weeks. In all but the acute form, there is a tendency for localisation of purulent foci in the joints, tendon sheaths, kidneys and other parts of the body.

This paper embodies a record of the mortality figures of foal septicæmia compiled during the course of practice in a heavy horse-breeding district in the

Midlands during the series of years 1931-1938, together with certain conclusions which have been formed.

Historical (Review of the Literature)

At first much speculation was entertained as to the cause of the condition, and many organisms were incriminated. As late as 1917 it seemed probable to some workers that *B. abortus equi* was perhaps the most common infecting organism.

The period 1914-1923 appears to have been particularly progressive. At this time Adsersen in Copenhagen, Magnusson in Sweden, M'Fadyean and Edwards in England, and Schofield in Canada were among others who were actively engaged in research into this disease. It was only after the various links in the chain had been connected by the various workers concerned that the ætiology was established.

Judging by the records given by the various investigators, on the whole there would appear to be a general close agreement between them. It seems generally agreed that the majority of cases are caused by three main organisms. The figures of Gaiger and Davies[1] are quoted as perhaps the most representative of the incidence in Great Britain. They are as follows:

Streptococci in 40-50 per cent. of cases;

Shigella equirulis (also known as *Shigella viscosa, Bacillus nephriditis equi, B. viscosum equi*), 25 per cent. of cases;

Escherichia coli, 25 per cent. of cases;

while *Salmonella abortive-equinus* and *Corynebacterium pyogenes* are each found in about 5 per cent. of cases.

Henning and Clarke[2] report isolating *B. salmonella typhi-murium* from the joint of a week-old foal; it therefore appears probable that at times other organisms in addition to those stated may be responsible for the cause of the disease.

While agreement has been reached regarding ætiology, there is more uncertainty regarding the mode of entry of the infection.

There are two main views:

(a) Primary infection of the umbilicus after birth.

(b) Intra-uterine infection.

Reviewing the literature on the subject, 1914-1923, with the exception of a few workers, such as Williams, Schofield, Sohnle, the majority favour extra-uterine infection as the primary cause of the disease.

(1) They contend that if infection were contracted *in utero*, it would be necessary to admit that mares are frequently the subject of chronic endometritis; that this is not true, as mares are rarely subject to this condition.

(2) In no case has a foal yet been discovered at birth with any developed lesions, such as abscesses or arthritis. Infection, with subsequent death, in a newborn foal has always been a septicæmia.

(3) Adsersen's and Magnusson's researches show clearly that there are species of joint-ill bacteria capable of causing symptoms and even death within twenty-four hours. None of the bacteria require a long period of incubation. It is, therefore, not necessary to invoke intra-uterine infection to explain the early deaths of foals.

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On the other hand, the more recent publications seem to favour the post-natal route as the most important portal of entry.

Dimock,[3] discussing streptococci, states that usually, if not always, this is a pre-natal infection of young foals. Also, speaking of *Shigella equirulis*, he further states that under favourable conditions this organism may gain entrance to the blood stream and be carried to the pregnant uterus, where it remains almost unaffected to the time when the foal is born.

It is the opinion of Dimock and Edwards[4] that the majority of foals that died of *Shigella equirulis* infection within the first week were the victims of intra-uterine infection. In support of this view they quote the following facts:

(1) The infection was found in aborted fœtuses and foals dead at birth.
(2) In a few instances the bacterium was demonstrated in the uterine exudate of the dam.
(3) The presence of symptoms of infection at birth.
(4) The extent, character and distribution of pathological changes.
(5) Preventive measures at time of birth apparently are ineffective in the control of the disease.

Schofield,[5] discussing *Shigella equirulis* and *B. coli* infections, states that these infections occur during the first few hours of birth, and that this early infection of foals, which are almost always noticed to be weak at birth, constitutes one of the major reasons for our belief that most, if not all, of these cases represent a pre-natal infection.

There is little doubt that the stimulus of all research on joint-ill has been the finding of some protective means of curbing the heavy mortality. Those which have held out the greatest promise of success have been the specific anti-sera and vaccines.

It must be admitted, however, that much diversity of opinion exists as to their value.

Various investigators have tried this treatment, and since Ostertag in 1901 stated that streptococci were the common cause of the disease anti-streptococcus serum has been somewhat extensively employed.

During the years 1917-1918, M'Fadyean and Edwards[6, 7, 8] issued to practitioners for the treatment of affected foals a serum from horses hyper-immunised with *B. abortive-equinus* under the impression that this organism was at least a common cause of joint-ill, and that the infection was contracted from the dam *in utero*. In the second year of the experiment blood tests from the dams concerned contra-indicated infection with this organism, and the inoculations were found to have no influence on the course of the disease.

In their second series of investigations they used in the first place anti-streptococcus serum obtained from horses hyperimmunised with strains of streptococci isolated from lesions in foals infected with joint-ill. This was used both curatively and prophylactically.

Later a vaccine was used, composed of dead streptococci. In-foal mares were inoculated at a month and two weeks before foaling and the foals were given two injections after birth.

As a means of control, figures were obtained from two leading insurance

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companies to show what proportion of foals may be expected to contract the disease or die from joint-ill under ordinary circumstances. The average ordinary mortality rate according to these figures is 2.8 per cent.

Quoting from the authors'[8] conclusions at the termination of the experiment, they state: "Treatment of either mares or foals, or both, with anti-streptcoccus serum or vaccine composed of killed streptococci, has no effect either in preventing joint-ill or in curing it, and it ought therefore to be abandoned."

The results of the work conducted by Danish veterinary surgeons and summarised by Vald. Adsersen are also given by these authors in support of their view.

Somewhat earlier than this, in 1916-1917, Magnusson[9] of Sweden carried out investigations. He states that preventive inoculation with a mixture of coli serum and streptococci serum and simultaneous vaccination with streptococci vaccines gives good results, and should be used in stables where joint-ill usually appears. He further points out the fact that *Shigella equirulis* and other bacteria occur in foals, causing joint-ill, which will reduce the chances of always obtaining positive results in foals treated with coli and streptococci serum.

With the exception of those of M'Fadyean, Edwards and Sheather, there are few records of similar investigations in Great Britain.

Peggie,[10] about 1918-1919 (the actual year is not stated), conducted prophylactic treatment on a limited scale in his practice.

He used a polyvalent streptococcus serum produced by a well-known laboratory. He gave two injections to the mare, the tenth and the third day before foaling, and a dose to each foal at three or four days old. The dose for the mare was 7 c.c., and 3½ for the foal. The first year eight mares and foals were injected and there was no case of joint-ill.

In the second year 60 mares were treated, the dose of serum was doubled, and the foals were treated 24 to 48 hours after birth. During this season not a single case of joint-ill was observed in the foals of the injected mares. Seventeen of these mares had during previous seasons given birth to foals that had developed joint-ill.

A number of mares in the surrounding district were not injected and the offspring of four of them developed joint-ill which proved fatal.

Between 80 and 90 mares were injected the following season, of which 99 per cent. produced foals which were free from joint-ill.

Robb,[11] on a limited scale, also claims excellent results. He treated mares with mixed vaccine injected three times at weekly intervals prior to foaling, and the foals with two injections 30 c.c. anti-streptococcus serum: the first as soon after birth as possible, the second seven days later. His results are as follows:

1919.— 6 mares and foals injected, one foal died (the mother of the foal died at foaling).
1920.—10 mares and foals injected; all remained healthy.
1921.— 8 „ „ „ „ „ „ „
1922.—21 „ „ „ „ „ „ „
1923.—14 „ „ „ „ 13 „ „
(one mare due had still to foal).

Schofield,[12] in a more recent article, states that the only natural mode of attack upon this disease is by the use of preventive measures. Limiting his discussion to bacterins, he admits that opinion is divided as to the value of biological products in the prevention of joint-ill, but adds that practitioners believe that biologics have a definite but limited value. As one who has advocated their use for 30 years, and who has been instrumental in the improvement of the product used, he believes that bacterins (chemically killed cultures) have an important place in the prevention of joint-ill.

In dealing with this subject he emphasises the importance of the following facts:

(1) That it is exceedingly difficult to establish a high degree of immunity against any of the organisms prevalent in joint-ill. All authorities are agreed on this point.

(2) Some of the bacterins placed on the market have been of doubtful value quality.

(3) It is usually an extremely difficult matter to assay in a truly scientific manner the results of such preventive administrations. Adequately controlled experiments cannot be made.

Further points stressed by Schofield which appear worthy of mention are:

(1) Only recently isolated strains should be used.

(2) The virulence of those should be preserved by desiccating them at low temperatures.

(3) The bacterin should be standardised by actual use on the horse.

Immunisation of the mare.—Schofield[12] advocates that this should be done early in pregnancy, during the advanced stage, and, lastly, during the last month, allowing the practitioner great elasticity with regard to intervals between injections.

Among 950 mares thus vaccinated there were 24 cases of joint-ill, or 2.05 per cent. The mortality among these was low—eight cases, 33⅓ per cent.

It is stated that a large percentage of mares treated had previously given birth to joint-ill foals or were living on infected premises.

Immunisation of the foal.—According to Schofield, this procedure is followed by some practitioners, the foal being injected as soon after birth as possible. Some years ago he carried out an experiment in foal immunisation. In almost every case the foal was injected on the day of birth. His results are summarised as follows:

Non-immunised foals in the same area	...	642
Foals immunised in the experiment ...	...	458
Cases of joint-ill among the immunised	...	14 (3 per cent.)
" " " " non-immunised	...	40 (6.27 per cent.)

It is further stated that the injected foals were at a disadvantage in being born on known affected farms.

The ideal method, according to Schofield, is to combine both, that is, to immunise the mare and foal when possible.

It is the opinion of Williams,[13] Dimock[4] and others that the problem of joint-ill cannot be controlled independently. It has often been observed that there

is a close correlation in the occurrence of delayed conception, sterility, abortion, still-births and diseases of the new-born, and that any attempt to control the disease must start with the mare.

Dealing with streptococci, Dimock[14] found that 25 per cent. of mares were suffering from streptococcal metritis and 25 per cent. of abortions were due to streptococci. Regarding *Shigella equirulis*, he states that it would seem to have its origin in the digestive tract and is readily recovered from the tonsillar crypts of the great majority of mares of all ages.

Dimock and Edwards[4] also found that streptococci infection attacks the foals of the same mare year after year, and also 21.5 per cent. of foals which were dead at birth or died within 24 hours were infected with streptococci. On the other hand, the statement that the infection attacks the foals of the same mare year after year is not, in their experience, applicable to infection with *Shigella equirulis*.

They further state that if there is any disease that can be controlled by hygiene, it is the streptococcal infection. If you want to increase the pregnancies, also the chance of having a live foal at term, the mares admitted for service must be examined and those showing infection treated. He further states that if the mare is not in foal the time to treat her is from September to January, and that a mare with a sunken or relaxed vagina can be treated surgically.

Williams,[13] Dimock[4, 15] and other workers have also stressed the danger of indiscriminate breeding at the first heat period after foaling, and that only those mares that have returned to normal at that time should be bred.

In connection with preventive measures, there is the important question of parasites, especially strongyles, and to what extent they may directly or indirectly add to the mortality.

As early as 1919, Magnusson,[9] discussing *Shigella equirulis*, recorded worm aneurysms in foals with infected thrombi. He states the *Sclerostomum vulgarem*, which lives in the intestine, is the one the larvæ of which wanders up the mesenteric root. In spite of the fact that these larvæ are found in great numbers in practically all foals over six months old, and cause aneurysms and thrombi, they do not seem to cause any visable illness to the carrier. If for some cause or other, however, bacteria gain access to the thrombus the animal becomes very ill, with symptoms of joint-ill, pneumonia and colic.

The illness appears when the colt is at least three months old, and then comes on very suddenly; the pulse and respirations are rapid, one or more joints are affected, and the foal moves about unwillingly. The newly discovered organism thus appears to have a very great importance as a pus-producer in horses.

Magnusson's[9] cases were in older foals, but Dimock[16] more recently states that well-developed verminous aneurysms are often found in foals from four to eight weeks old. As pointed out by Dimock, it is immaterial whether the worm parasite actually carries the bacillus to the blood vessel or whether the bacillus enters the blood stream by other means and later localises in the diseased area. However, in that the micro-organism does find its way into the circulation of young colts, it may with equal facility find its way into the circulation of the brood mare. In mature horses there is marked resistance or tolerance to

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S. equirulis. On the other hand, young colts are readily susceptible to infection by this micro-organism.

May it not be that *S. equirulis* finds its way into the blood stream of the brood mare, and through its predilection for the tissues of the young equine readily finds its way to the fœtus within the confines of the pregnant uterus?

Forssell,[17] who assumed that the infection of joint-ill is of intra-uterine origin, appears to have been the first to popularise the use of the dam's blood which seems to have been used fairly extensively in Europe as a therapeutic measure. He cites 127 recoveries out of 157 cases treated.

Forssell states that when a mare does not suffer from the infection she is supposed to carry antibodies against it.

Quoting Sohnle (*Zeitschrift Für Gestutskunde*, 1910, Part 11), he writes that the new-born, also, inherits such antibodies, and this explains why the foal does not contract the disease before the lapse of ten days or more; he writes, also, that he believes the serum of the dam could be used as a prophylactic on the foal while it would add to the opsonian power of the foal's blood.

Sohnle, apparently, only used serum from a serum horse treated with cultures from foals which had died of joint-ill.

In order to be able to use the serum from the dam there must be at least one day's delay. Forssell therefore recommended the method of injecting the blood direct from the dam.

Clinical Observations

The district concerned is a Shire horse breeding and dairying area. The records, therefore, mostly concern Shire foals. The nature of the land is fertile, permanent pasture.

In common, perhaps, with most heavy horse breeding districts, joint-ill or foal septicæmia has been the most serious handicap to breeding.

The disease is found in all its various forms, or may possibly best be considered as a number of separate and distinct affections, each taking a varied course and differing according to the nature of the infecting micro-organism. It may be acute, sub-acute or chronic.

The first two are variations in degree often difficult to differentiate in practice. The foal may be born dead in spite of every attention at foaling; it may be born sickly, never suckle the mare, and die within a few hours of birth. If the foal lives longer, it may develop pneumonia, diarrhœa, and after 24 or 48 hours a joint may be noticed swollen and painful. Post-mortem examination will usually show only the usual signs of septicæmia, moist and œdematous lymph glands, injected serous membranes, small hæmorrhages on the heart muscle, and a degenerated condition of all organs. These cases have usually been considered due to *Shigella equirulis*, but according to Dimock's[4] findings a considerable proportion of acute cases are due to streptococci.

In the sub-acute forms, which may last three or four days, the respirations may be accelerated and the temperature 103° or 104° F. There will be frequent urination, as in other forms of the disease.

The foal will be dull and listless and rapidly grow weaker. Post-mortem examination will show the same degenerative changes, but the navel may show

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little change; there will be fluid in the heart sac and perhaps a small quantity of blood-tinged fluid in the pleural or peritoneal cavities. A joint will probably be affected, and if due to *S. equirulis* the kidneys may be degenerated, hæmorrhagic or be studded with varying degrees of abscess formation.

Coli infection (?).—There is a further acute form. Usually sickly when born, affected foals may attempt to suck at first, but are soon down and unable to rise, with a characteristic grunt of acute pain and a peculiar jerking back of the head. They rarely live more than 36 or 48 hours. Post-mortem examination in these cases invariably shows an acutely inflamed stomach and small bowel, and the fæces are blood-stained. The serous surface over the bowels are petechia studded and deeply injected. These cases are believed to be coli infections.

Sleepers.—Another condition is met with where the symptoms are seen at birth and in which the affected animal is commonly called a sleeper. They have a doped appearance when born, refuse to suck or stand. If roused, the response is only temporary, and they fall back in a semi-comatose condition. Without treatment the foal usually dies within 24 or 36 hours.

Dimock[3] considers these cases are due to *Shigella equirulis* infection, although Good and Smith[18] record a sleeper foal born from a mare in which a bacterin made from *B. abortive-equinus* which did not sufficiently protect her against an intravenous injection of 2 c.c. suspension of the same organism, to produce a strong, healthy foal.

There is a further condition which may be a mild degree of the sleeper foal. It is the foal which is difficult to suckle. It is the experience in the practice concerned that this condition, with few exceptions, is pathological.

A case from which *Corynebacterium pyogenes* was isolated was found sickly at 48 hours after birth. The foal showed pneumonic symptoms and rales were audible over the chest; there was a pronounced grunt when the foal was down. The temperature was 102.8° F., and rose to 103.2°. The animal died when four days old.

Post-mortem examination showed the lungs adherent to the pleura, with a yellow membranous exudate. The pleural cavity was filled with a putrid purulent fluid. The navel showed a dark red inflammatory condition which could be traced up into the abdominal cavity.

The stomach was much less inflamed than in the condition described as possible coli infection, in which there were no lung lesions.

Another somewhat similar case which died at four days old, but in which the infecting organism is not certain, showed pneumonic symptoms and a swollen near hock. The navel was inflamed, there was a fibrinous pleurisy and deposits of fibrin round the heart, as seen in traumatic pericarditis in cattle. There was also much fluid in the pericardial sac, but the kidneys appeared normal.

In the more chronic form, in which streptococci are considered the predominant infecting organism, strong, vigorous foals are smitten.

The affection is usually ushered in by an elevated temperature at four to ten days old, which usually goes unobserved. A slight lameness is first noticed,

which frequently is attributed to a kick or strain and not treated seriously until arthritis develops. The arthritis has a particular tendency to pus formation.

The lameness may develop with remarkable rapidity into the septicæmic form, with death in the course of a day or two, or it may take a protracted course with acute lameness, the animal perhaps lingering on, showing extreme emaciation, and succumbing from exhaustion after several weeks.

It has been found that where lameness spreads from one joint to another limb the condition nearly always takes a rapid course to a fatal termination.

This also applies to open joint, which cases, with few exceptions, have a fatal termination. A few cases have made excellent recoveries and have fetched large figures, but it is not unusual for such cases to die from a metastatic abscess at one or two years old.

Post-mortem examination: The chronic form of joint-ill presents a variety of symptoms according to the length and severity of the illness. The navel is inflamed and purulent, there is invariably a suppurative arthritis, and the joint cartilage frequently is involved.

Huge purulent abscesses are common; for instance, if the stifle happens to be involved there is often an enormous abscess extending along the course of the muscles to a remarkable extent, with metastatic foci in the lungs, liver or other organs. In some cases it has been observed that the original seat of joint lameness has cleared up and shows no macroscopic pathological change.

Pneumonia symptoms.—There is a further condition in which the predominant symptom is a pneumonia attacking at any age up to ten days old. It is uncertain if this is a separate entity, but the fact that the foal may develop joint symptoms at any stage of the attack makes the condition difficult to differentiate in practice.

Diarrhœa.—Less frequently a diarrhœa is the primary symptom; here, again, joint lesions may appear during the course of the attack.

Cases have also been encountered which compare very closely with the delayed cases in older foals, as mentioned by Magnusson. Case No. 144 was a protective inoculation, but it was probably affected at birth as it was off colour the days succeeding vaccination. It then thrived until two months old, when it died showing colic symptoms and generalised septicæmia. Post-mortem examination showed the infection to extend from the navel to the liver. The kidneys also showed lesions suggestive of *Shigella equirulis* infection. Unfortunately, a worm aneurysm was not looked for.

Three cases in older foals have been encountered, all of which developed similar nervous symptoms.

Foal No. 223 developed typical joint-ill with swollen joints; it was treated for about three weeks, when it made an apparently good recovery. Approximately three weeks ensued, when a request was received to examine the foal again. It would eat but had a difficulty in standing, and would stand with all four limbs as far away from the body as possible in order to form a prop. It finally went down and was destroyed. Professor Craig kindly made a bacteriological examination and reported the presence of *Shigella equirulis* in the kidney.

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A similar case, in a well-grown foal about eight weeks old, showed similar staggering symptoms with inco-ordination of the limbs.

The foal is not recorded as it was not treated for joint-ill. The owner actually received a lightning claim; indeed, the symptoms were most suggestive. It was only when good fortune occurred to make a post-mortem examination that a necrotic kidney was found, believed to be due to *Shigella equirulis* infection.

A case showing identical nervous symptoms with all limbs thrown out as a prop was a Suffolk foal treated more recently. It was first treated for a swollen near hock and leaky navel. This case was treated with Prontosil and made an apparently excellent recovery.

Exactly two weeks later it developed nervous symptoms as described above. Post-mortem examination showed numbers of hæmorrhages in the liver the size of a walnut and on the external surface of the kidney. Bacteriological examination was negative. It was suggested by Professor Craig, who kindly carried out the laboratory examination, that these hæmorrhages, which may have been disseminated in other organs, including the nervous system, may have resulted from damage to the blood vessels by the infection. This, therefore, would suggest that these particular nervous symptoms are not connected with any particular organism.

Other Diseases Closely Associated with Joint-ill

Pervious urachus.—The imperfect closure of the urachus with the dribbling of urine is observed so commonly complicated with joint-ill that it is mentioned here. It may occur conjointly with it, or joint-ill may be noticed to follow quickly in its wake. It has therefore been found necessary to view pervious urachus as a serious condition.

Retention of the meconium.—Bullet-like fæces have been found so frequently in newly-born foals as to appear almost normal.

It has been observed that retention of the meconium after birth is frequently associated with septicæmic symptoms. Williams[19, 13] believes that in many cases infection has existed in the uterine cavity of the dam, and also it is analogous to calf diarrhœa.

Deformed foals at birth.—Deformities of varying degrees and varieties are met with. The pathology does not appear to be satisfactorily determined. Fincher[20] supplies evidence to show the condition does follow a diseased uterus in the dam.

Mortality

In the acute forms occurring a few hours after birth Udall[21] gives the mortality at 90-100 per cent. He further states that in the streptococcal forms showing navel infection or lameness, but no general symptoms, the average death rate has been estimated at 30 to 75 per cent. These estimates are qualified by the statement: "These estimates are based on superficial observations and they have little relation to the expectation in any given outbreak."

The following table gives the mortality figures in the district under discussion during the years 1931-1938:

Year.	Unvaccinated.	Developed Symptoms.	% Affected.	Died.	% Mortality.
1931 ...	51	11	21.5	9	17.6
1932 ...	41	13	31.7	10	24.3
1933 ...	67	20	29.8	13	19.4
1934 ...	48	10	20.8	4	8.3
1935 ...	51	18	35.2	10	19.6
1936 ...	55	14	25.4	10	18.1
1937 ...	50	8	16.0	5	10.0
1938 ...	39	13	33.3	7	17.9
Total ...	402	107	26.6	68	16.9

It will be seen that from the years 1931-1938 there is a consistent heavy incidence of joint-ill amongst foals in the district under discussion.

The lowest year, 1937, showing 16 per cent. affected, is the year in which the writer's records are not complete, and it includes only those known to have been affected. It is almost certain that some have been omitted and that the correct figure would agree more closely with the other years.

Untreated

The total number of foals during that period is 402. Of these, 107, or 26.6 per cent., became affected with joint-ill, of which 68, or 16.9 per cent., died.

Susceptibility.—In dealing with mortality there are certain unexplained factors both of susceptibility and resistance which in some cases have an important bearing on the course of the disease, and the solution of which might assist in methods of prophylaxis.

Susceptibility is a factor to be taken into account. It seems probable that the progeny of pedigree mares, especially those that have a lot of care expended on them, receive heavy feeding and do little work, are more predisposed to joint-ill. A scrutiny of the foals in this report shows that the mortality is highest in the better-bred stock.

It has also been observed, on the other hand, that where ordinary working horses are bred and worked hard, and where no care is expended on breeding operations, the mortality is remarkably low. This latter statement, however, has its limitations. It is the writer's experience that on farms which have been disease free, once disease is introduced this resistance is easily broken down, and that if not checked the disease will develop rapidly.

One well-known Shire breeder can be cited. He insisted on foaling his mares in boxes and paddocks round the house until the infection became so acute that it was almost impossible to rear a live foal. Conversely, the owner of foal 150 and others had recurring trouble, moved to new premises and for several years were without a case of joint-ill. A number of cases could be quoted from these records where the owner never had joint-ill, but where, once introduced, it occurred each year.

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In contradistinction to susceptibility there appears to be an unexplained resistance factor. Blood foals appear much more resistant than Shires. It has also been observed that in Shires there appears this same factor amongst individuals, even on farms where extensive breeding operations are carried out.

Foal No. 120 is an illustration of this type of case. Shortly after the foal was born, the mare developed parturient laminitis with a filthy exudate in the uterus. The foal was small and nondescript. On one occasion the mare was seen to expel the contents of her uterus completely over the foal's head. The environment was ideal for the development of trouble, but, contrary to expectations, the foal thrived.

There is also the one-in-a-thousand chronic case which makes a good recovery. Foal No. 207 illustrates this type of case. The joints were affected, the foal was emaciated and desperately ill for weeks, yet finally it made a good recovery.

There is also the acute case of No. 209, seen at birth in the middle of the night and so ill as to be thought beyond treatment.

A dose of vaccine was the only treatment this foal received. It was small and stunted, dosed for redworm as a yearling, and went on well.

Nevertheless, the cases cited are outstanding exceptions of resistance and do not detract from the usual necessity of unremitting therapeutic measures.

Prophylaxis and Treatment

Protective Inoculation of the Foal.

During the years 1919-1922 the predecessor of the writer in the practice concerned was one of the collaborators with the late Sir John M'Fadyean in the field work he conducted, inoculating a number of foals with an anti-streptococcus serum and later a vaccine supplied by him. At the end of the investigations, however, this practitioner was left with no alternative but to report that the inoculations, as far as his experience was concerned, were valueless.

It was primarily for this reason that little attention was given to prophylactic vaccination until a few years ago.

Vaccination was, however, used in combination with other forms of treatment as a curative measure, and when attendance was necessary to remove the afterbirth from a mare a dose of joint-ill vaccine was given to the foal. In 1931 four foals were inoculated in this way.

War-time conditions have prevented earlier completion of the results. While these are not spectacular, it is considered that they may yet be of sufficient interest, together with the other measures adopted, to justify a report.

The results of protective inoculation were judged at the time by the freedom from subsequent illness of those foals that had appeared definitely healthy at the time of inoculation. It was only when it was decided to record the results that it was realised that some control figures were necessary. This was a difficult problem, as it is impossible to obtain a record of foals dropped in a district during a particular foaling season. As, however, all Shire foals, with extremely few exceptions, are docked each season in this district, it was decided to take the number of foals docked plus the dead foals as the total number of foals

born. This record will not include aborted foals or foals dead at birth. It will, nevertheless, form a consistent estimate of the approximate number of foals born each season.

NON-TREATED.				TREATED PROPHYLACTICALLY.			
Year.	Unvaccinated Foals.	Developed Symptoms.	Died.	Year.	Vaccinated Foals.	Developed Symptoms.	Died.
1934	48	10	4	1934	13	2	2
1935	51	18	10	1935	17	2	1
1936	55	14	10	1936	53	2	2
1937	50	8	5	1937	49	2	1
1938	39	13	7	1938	57	5	1
Total	243	63 (25.9%)	36 (14%)		189	13 (6.8%)	7 (3.7%)

It will be noted that of 243 unvaccinated foals, 63, or 25.9 per cent., developed joint-ill symptoms, of which 36, or 14 per cent., died. Of 189 vaccinated foals, 13, or 6.8 per cent., developed joint-ill symptoms, of which 7, or 3.7 per cent., died.

1934

The first real attempt at protective inoculation was started in 1934. In that year the joint-ill combination supplied by the International Serum Company was used. It consists of 20 c.c. pyosepticum viscosum serum and 10 c.c. streptococcus vaccine.

In all, 13 foals were inoculated as soon after birth as possible. Of these, two developed joint-ill and both died; one, No. 79, developed the acute form and died 48 hours after birth; the other, No. 64, developed chronic joint-ill a month after inoculation and finally died.

It is unusual in the practice concerned to find a foal developing symptoms of joint-ill at a month old.

1935

Working on the assumption that the inoculation might have given some degree of protection, but that such portection was inadequate, it was decided in the season 1935 to increase the dose of serum from 20 c.c. to 60 c.c. (The serum was prepared for use against *Shigella equirulis*, streptococci, and *B. coli*.)

The decision was influenced by the good recovery of the second foal of the season, No. 83. This foal developed acute lung symptoms soon after birth. After receiving 60 c.c. of curative serum and a following 60 c.c. twelve hours later, it made a quick and complete recovery.

A further difference in the method was that a mixed vaccine was substituted for the streptococcus vaccine used. This particular vaccine was manufactured at Laigle under the supervision of Dr. Blaizot and sold under the proprietary name of "Tregor." The only reason for this alteration was that this particular vaccine had been used extensively by us for curative purposes as well as in

certain cases prophylactically and it appeared to be of value. The inoculations from now on were all made with this particular combination.

The composition of this vaccine is given as follows:

Streptococci	100	millions	per c.c.
B. viscosum-equi	500	„	„ „
B. coli	500	„	„ „
B. abortus-equi	200	„	„ „
Staphylococci	200	„	„ „
B. boviseptica	200	„	„ „
B. paratyphi B.	100	„	„ „
B. pneumoniæ (Friedlander) ...	100	„	„ „

It is stated that the vaccine has been rendered detoxicated so that the dose is borne without the slightest reaction, either local or general. (The writer can endorse this statement.)

In 1935, therefore, 17 foals received, as soon after birth as possible, 2 c.c. of the above vaccine and 60 c.c. of polyvalent serum, both subcutaneously.

Of the 17 foals thus inoculated, 14 went on well. Two developed symptoms of joint-ill, one dying and one recovering. In addition, one developed sleepy symptoms 48 hours after birth; it received dam's blood and recovered.

In the same season, of approximately 51 uninoculated foals, 14 developed joint-ill symptoms, with 10 deaths and four recoveries. In addition, four developed lung symptoms. Two of these received dam's blood, one serum and one S.U.P., and all recovered.

1936

The results were sufficiently encouraging to justify a continuance of this form of inoculation. In 1936, 53 foals received protective treatment. Of these, two developed symptoms, one dying soon after inoculation; the other developed symptoms at ten weeks old.

Of the 55 uninoculated animals, 11 developed symptoms of joint-ill, with nine deaths. In addition, two of the uninoculated were sleepers, one of which died. One foal also developed lung symptoms, but after serum treatment recovered.

1937

It is unfortunate that the figures for 1937 are not complete, lacking records of the number of non-inoculated foals.

Records are, however, available to show that 49 foals received protective inoculation, two of which developed symptoms of joint-ill, one dying and one recovering.

Two received vaccine only and showed no symptoms.

Figures are also available to show that at least eight of the unvaccinated foals became affected, of which five died and three lived. Judging on an average basis, there would be approximately 50 uninoculated foals, and almost the same ratio exists in this year in favour of the inoculated foals.

1938

In 1938, 57 foals received protective inoculation, of which five developed symptoms, with one death and four recoveries.

Of the 39 uninoculated foals of the same year, 12 developed symptoms of

joint-ill; of these, seven died and one developed symptoms of enteritis, of which no other cause but a septicæmia could be found.

Treatment of the Foal with Dam's Blood.

Inoculation of the foal with dam's blood was first attempted as a curative measure in 1924. During the years under review, 1931-1938, 33 foals were treated in this way, some receiving two or more injections.

The treatment was applied to foals showing symptoms of joint-ill or septicæmia, to cases showing lung symptoms only, and also to foals which were sleepy at birth, refused to suck and were unable to stand, commonly referred to as sleepers.

The method of injecting was to draw the required quantity of blood from the mare's jugular vein into a suitable vessel containing approximately 50 c.c. of a 2½ per cent. solution of sodium citrate made with distilled water for each 500 c.c. of blood. The blood, which is slowly stirred during the process, is injected subcutaneously into several sites in the foal's neck, usually placing 50 c.c. in each site. The dose given varied from 250 c.c. to the usual amount of 500 c.c.

The injection invariably causes temporary shock, after which a stimulant effect is almost always noticed, even if it is not permanently maintained.

	JOINT-ILL.			LUNG SYMPTOMS.			SLEEPERS.		
	No.			No.			No.		
Year.	Treated.	Lived.	Died.	Treated.	Lived.	Died.	Treated.	Lived.	Died.
1931 ...	2	—	2	—	—	—	1	—	1
1932 ...	2	—	2	1	1	—	—	—	—
1933 ...	5	3	2	—	—	—	1	1	—
1934 ...	2	1	1	1	—	1	3	3	—
1935 ...	8	2	6	2	1	1	1	1	—
1936 ...	—	—	—	—	—	—	1	1	—
1937 ...	1	1	—	1	1	—	—	—	—
1938 ...	1	—	1	—	—	—	—	—	—
Total ...	21	7	14	5	3	2	7	6	1

It will be noticed that of

21 Joint-ill cases, 7 lived and 14 died.

5 Lung cases, 3 „ „ 2 „

7 Sleepers, 6 „ „ 1 „

The foals included in the table were treated indiscriminately without regard to the degree of infection. The table thus does not give a correct estimate of the value of the treatment, which obviously lies in its early administration.

The Sulphonamides.

During recent years the sulphonamides have become a valuable addition to our means of combating joint-ill. They are especially indicated in these cases caused by a hæmolytic streptococcus.

The writer has had a limited experience with this form of treatment. It was found the two chief obstacles to their use to be the danger of frequent

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dosing with the powder and the fact that the soluble form of M. and B. 693—the most likely available to prove effective—is particularly irritant to equines.

Prontosil was, however, found to be of definite value and well tolerated, and since Schofield[12] recommended cod-liver oil as a vehicle for sulphanilamide this has obviated the necessity of drenching. Vivicillin has been tried on one case, but as it was used in combination with sulphonamides it is, unfortunately, impossible to assess its value.

It is believed that the future value of sulphonamides lies in other members of the group, not yet available for veterinary use.

Few other lines of treatment have been attempted. In lung cases it has been the writer's practice to apply a Kaolin poultice to the chest. It is applied fairly thickly, well covered with cotton-wool, and stitched in position and left on until the foal is completely recovered. This allows warmth while the foal has plenty of fresh air, and appears of definite value. It is considered, further, that the early application of counter-irritation to the affected joint is of the utmost value: a painless liquid blister for three successive days, or alternate days, according to the case. This is well tolerated by very young foals. In addition, cod-liver oil is given with malt in the form of electuary, but latterly this has to some extent been replaced by sulphanilamide.

Hygiene

Preventive inoculation by sera and vaccines is an attractive and, if successful, comparatively easy way of controlling foal disease, as it entails the minimum of trouble to the horse-breeder.

Preventive measures by hygiene, although more important, entail trouble and patience, and are, therefore, much less popular and more difficult of administration.

The following measures are considered of major importance in controlling joint-ill: (1) Hygiene of breeding premises; (2) breeding hygiene; (3) correct feeding; (4) improvement of pastures: (5) control, as far as possible, elimination of parasites, especially strongyles.

Hygiene of Breeding Premises.—The records would indicate that loose boxes and paddocks inhabited by infected foals carry the infection from season to season, and in the usual construction of farm buildings the ordinary methods of disinfection are useless.

It is also suggested that the infection may be contracted from other species. It is of interest to note that in 1935 one of the two foals which contracted joint-ill after receiving protective inoculation was in the same small paddock where lambs were affected the previous season. In 1937 the only inoculated foal that died was in the same paddock. Blakemore,[22] investigating joint-ill in lambs in East Anglia, found that streptococci were the commonest infecting organisms.

This mode of infection is strengthened by the recording of Henning and Clark[2] of a case of joint-ill in a foal due to *Salmonella typhi-murium*, in which they state the premises had not been used previously for stabling horses and the hygiene and management appeared beyond approach. However, some calves had been housed in the building by the previous owner which had developed a disease thought to be para-typhoid.

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Notwithstanding the above, although less often, all forms of joint-ill do occur even in the ideal conditions of spring where there has been no known previous infection.

Breeding Hygiene.—The neglected field of breeding hygiene offers, perhaps, one of the widest fields of opportunity for the prevention of foal diseases. It would appear that a disregard for this subject is the cause of a considerable volume of loss. It has been observed that unless some extremely obvious defect is present, the average mare receives but scant attention after foaling, much chronic disease goes unheeded, and a similar apathy is present prior to service.

Particular attention is necessary for mares whose foals have died at birth or which have had abnormal foalings. In this respect it has been noticed that certain mares give birth to dead and sickly foals each year. The elimination of the carrier mare is of first importance.

The new-born foal requires equal care and attention, although it is doubtful if tying the navel, as conducted by the average layman, has any value whatsoever. With the exception of cases of hæmorrhage, it has not been the practice to ligate navels, and the results appear to be as satisfactory, or more so. The navel should, however, have frequent treatment until healed, using a potent non-irritating dressing, such as one of the acridine dyes. If a caustic dressing is used the navel appears to dry up, break off and leave a further wound-exposed surface.

Correct Feeding.—With regard to feeding, there are two important aspects to be considered in Shire horse breeding. The first is excessive feeding for show purposes. This is directly harmful to mares and foals and must be suspected as a contributory cause of joint-ill. The second aspect varies from under-feeding to the more common condition of lack of balance in the ration. Field experience indicates that there is a correlation between a correct ration and healthy offspring.

The high percentage of bent limbs in otherwise healthy Shire foals points to some general deficiency in the ration.

There is also the question of bullet-like fæces in newly-born foals, which is met with so frequently as to be considered almost normal. Is this concerned with dietetics, or, as Williams states, after infection?

Pasture Improvement.—Some pastures are worn out; others seriously depleted, badly drained, sour or rank, or suffering from over- or under-stocking. In the district under consideration, commercial milk selling has been carried out over a long series of years without any methodical attempt to return the losses the land has sustained. The occurrence amongst the cattle of tetany and other deficiency diseases indicates that the land is lacking in various substances necessary for health. From investigations at the Rowett Institute[23] it would appear that rate of growth, underpercentage of fertility and health are roughly parallel with the percentage of "silica-free ash," and they also show that there is a definite correlation between minerals and protein. It is considered, therefore, that pasture improvement is intimately concerned with joint-ill prevention.

Control of Parasites.—It is not known definitely to what extent parasites are directly responsible for joint-ill, but their incrimination, together with the other harm they do, makes their control of vital importance to disease prevention.

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Experience has shown that many of the paddocks and pastures used are horse sick, teeming with strongyle and other worm infection. Dosing of both mares and foals has been carried out with excellent results, but unless done systematically it only touches the fringe of the subject. All equines should receive routine treatment; in addition, all dung pads should be broken up and, where possible, removed.

Rotational grazing, as recommended by Britton,[24] is a further practical means of control, whereby each pasture receives a three weeks' rest, which serves to kill or render non-infective many potentially infective strongyle larvæ.

Discussion

From the review of the literature tabulated earlier in this report it would appear that there is general agreement on the main causes of joint-ill. On the other hand, the method of infection and the value of prophylactic measures have not been so satisfactorily settled.

With reference to the method of infection, investigators of great experience on equine diseases hold decided views, and there is no evidence of unanimity.

This applies still more plainly to the value of prophylactic measures, where the views are even more conflicting.

Reviewing these limited clinical notes, in the first place they show in the district concerned a consistent heavy mortality. Table 1 shows that during the years 1931-1938 the number of foals to become affected with joint-ill was 26 per cent. and the average mortality 16.9 per cent.

Contrary to the view of many observers, experience in this district shows there are no good joint-ill years.

It is true that in 1934 the mortality rate is down to 8.3 per cent., but 20.8 per cent. became affected. It therefore cannot be called a good year.

The figures for 1937 are not complete, and it is certain the incidence was heavier in that year.

The mortality table shows a striking contrast to the mortality figures compiled by the insurance companies of 1.8 per cent. for Great Britain as a whole.

Prophylaxis.—In spite of the disappointing earlier foal vaccination results in this district, prophylactic inoculation appeared to be of definite value in reducing both the incidence and mortality of the disease.

For the five years 1934-1938 the results were as follows:—

Unvaccinated Foals.	Developed Symptoms.	Died.	Vaccinated Foals.	Developed Symptoms.	Died.
243	63 (25.9%)	36 (14%)	189	13 (6.8%)	7 (3.7%)

From an examination of the records of the foals that developed symptoms or died after protective inoculation, it seems probable that a number were affected at the time of inoculation, were exposed to unusual infection, or, in one case, suffered from a worm aneurysm.

Three affected foals also made a rapid recovery after receiving dam's blood or serum.

It is realised that the use of the biological products employed may have been unscientifically balanced. In the absence of any centrally controlled laboratory dealing with diseases of foals, choice of products was limited to those obtainable which appeared to be of value.

Experience shows that large doses of serum should be used.

Protective inoculation of the foal, however effective, must necessarily have a limited value, as it is unlikely to have any effect on the foal which has the disease established at birth or immediately after. Inoculation of the dam, as recommended by Schofield, used conjointly with that of the foal, offers important additional advantages.

Treatment.—Experience shows that the treatment of an established case of joint-ill is useless. This also applies to a considerable proportion of cases that do not show advanced symptoms but in which, if it was only possible to ascertain the fact, it would be found that some deep-seated or organic lesion is already present.

With few exceptions, blood or any other treatment adopted is of little value where a joint affection is firmly established.

Notwithstanding the above statements, the records show seven cases of typical joint-ill in which blood inoculations appeared of definite value; most showed a joint affection, and foal No. 54 showed both a swollen near hock and off stifle. One made an outstanding, spectacular recovery, and judging from the usual course of the disease the recovery of the remainder was extremely satisfactory.

During the same period three foals showing lung symptoms were successfully treated.

With regard to one of these, the dam showed almost identical lung symptoms herself as a foal and received blood inoculation April 4, 1928.

The records show that a larger percentage of lung cases respond to treatment than those suffering from joint-ill. The most spectacular recoveries, however, have been seen in the so-called sleepers, of which six of the seven treated made good recoveries.

Two foals, Nos. 97 and 179, illustrate this type of case. Both were on the same farm in different years, they both looked hopeless at the time of injection, and both were up and sucking the following morning.

There also seems evidence to show that cases which developed symptoms after prophylactic vaccination responded quickly to blood inoculation.

A number of Forssell's[17] cases were inoculated intravenously; the inoculations recorded here have been by the subcutaneous method. An analysis of the 26 in which the route is recorded by Forssell shows that 13 inoculations were given intravenously, with one death, and 13 given subcutaneously, with three deaths. It would not appear, therefore, that there is any great advantage in the intravenous route.

Dam's blood has not been used as a prophylactic measure in the district concerned, although it was recommended for this purpose. It is realised it would

be of more value as such, but, owing to temporary shock following its use, serum appeared to have advantages for use on healthy animals.

Summary and Conclusions

(1) The records show that the ordinary average foal mortality rate in a Shire horse breeding district in the Midlands for the eight years 1931-1938 was 16.9 per cent.

The number of foals to become affected with foal septicæmia during the same period was 26.6 per cent.

(2) During the five years that prophylactic inoculation of the foal was carried out (1934-1938) the mortality of the untreated foals was 14 per cent., while the mortality rate of those receiving prophylactic treatment after birth was 3.7 per cent.

The number of foals to become affected with foal septicæmia during the same period was: Untreated, 25.9 per cent.; treated, 6.8 per cent.

(3) Treatment with dam's blood in the early stages of disease is considered a valuable adjunct to the treatment of foal septicæmia.

It gives better results in lung cases than in joint cases and is especially valuable in the treatment of so-called sleepers.

(4) It is suggested that treatment with both dam's blood and serum has further reduced the mortality rate both in inoculated and non-inoculated groups.

(5) The foal mortality rate is much heavier in Shire horse breeding districts than the low percentage of 2.8, the figure arrived at from the reports of two leading insurance companies for the country as a whole.[8]

It is also considered that the ordinary average mortality figure given of 16.0 per cent. is a conservative estimate, as it does not include foals born dead without treatment or foals born prematurely.

(6) Further research on diseases of foals is an urgent necessity in this country.

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(*To be concluded*)

CLINICAL ARTICLE

AN INTERESTING SARCOMA IN THE THORAX OF A PIG

By D. LUKE, B.Sc., M.R.C.V.S.
Stormont, Belfast.

At a post-mortem examination on a young pig, carried out at the above laboratory, extensive tumour formation was found in the thorax. The condition exhibited several interesting features, and in view of the apparent rarity of the condition it was thought worth recording.

Subject.—A half-bred York female, about 70 lb. weight.

History.—This pig was one of a pen of six. All had been thriving well and putting on weight normally. No symptoms of illness had been seen by the owner, and the pig was found dead.

Post-mortem Examination.—The carcase was well nourished and in good condition. There were well-marked, sharply-defined, purplish areas extending

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over the neck, flanks and legs. The abodmen was much distended with gas. There were about two pints of dark, bloody fluid in the abdominal cavity. The liver was markedly congested.

In the thorax there was a greyish tumour mass, weighing 22 oz., situated in the mediastinum, anterior and ventral to the heart. The heart was slightly displaced backwards and upwards. There was excess pericardial fluid. Secondary growths occurred up to the size of a chestnut on the outer aspect of the pericardial sac. The heart muscle was rather pale and more flabby than normal. The heart was of average size.

The apical lobe of the right lung was almost completely replaced by new growth. Secondaries occurred throughout the cardiac, intermediate and diaphragmatic lobes. These varied in size from that of a small pea to that of a large marble. There was an elongated cluster of nodular growths in the vicinity of the bronchial glands, which appeared to have been completely replaced by the new growth.

The left lung was macroscopically normal.

A flat, plaque-like tumour mass completely covered the costal aspect of the right pleural cavity. It extended from the region of the sternum to the head of the ribs. It varied in thickness up to about ½ in. A flat extension of the growth over the ribs extended on to the pleural aspect of the diaphragm postero-dorsally. This measured about 5 ins. x 2 ins. x ½ in. The diaphragmatic part did not extend across the mid-line.

The left pleural cavity was macroscopically normal. No extension of the growth was found beyond the thoracic cavity. The carcase lymph glands were all normal to naked-eye examination.

Histologically, the tumour proved to be a small, round-celled sarcoma. It appeared to be rapidly proliferative, and mitotic figures were fairly common. The stroma formation was very scanty and there was some internal hæmorrhage.

The interesting features of this sarcoma were:

(1) Its occurrence in such a young pig.

(2) Its limited distribution in the right lung and right pleural space.

(3) That such an extensive growth could be present without the pig showing any symptoms.

ABSTRACTS FROM CURRENT LITERATURE

POSTERIOR PARALYSIS ASSOCIATED WITH INTERVERTEBRAL DISC PROTRUSION IN THE DOG

By W. H. RISER

North American Veterinarian, October, 1946, 27, *No.* 10.

NERVOUS disorders arising from protrusion of the dorsal or lumbar intervertebral discs into the spinal canal are quite common in certain breeds of dogs, particularly the Pekingese, Dachshund and Cocker Spaniel, and occur chiefly at middle age. The symptoms of the condition may vary according to the degree of protrusion from a skin hypersensitivity posterior to the lesion, in the mildest cases, to a total flaccid posterior paralysis where the spinal cord is greatly involved. Between these two sets of symptoms there is a third, in which all

musculature obtaining its nerve supply from the part of the cord posterior to the protrusion is in a state of partial or complete spasm.

Protrusion of a disc follows on strain, particularly after sexual activity, falls or jumping, where flexion of the spinal column occurs accompanied by sudden trauma. This will be sufficient to compress the disc, and as all the pressure during flexion is applied to the lower part of the annulus fibrosus, some displacement will occur dorsally of the disc substance, which includes the nucleus pulposus, the semifluid vestige of the notochord lying in the centre of the annulus. The nucleus pulposus, obeying the laws of an incompressible fluid, will transmit the pressure upwards on to that part of the annulus fibrosus adjacent to the spinal canal; and should the annulus be weakened by defective nutrition, development, conformation of the spine, or by incomplete closure of the embryonic chorda canal, a partial or complete rupture of the ring will occur. The former will give a herniation and the latter the escape of the semi-fluid nucleus pulposus substance into the spinal canal.

The pressure of these displaced tissues on either side of the superior common ligament on to the base of the spinal cord is sufficient to give symptoms, even when the degree of displacement is minute, as in this region there is a very narrow sub-arachnoid space.

Sequelæ and prognosis of the condition will vary according to the damage to the spinal cord, but in time, with good feeding and rest, the nucleus pulposus substance in its changed position will "dry" and retract, thus relieving the pressure on the cord, and the symptoms of a mild case will then abate. In cases of total paraplegia a high protein diet will assist in the reabsorption of œdema at the point of injury, but at the same time assistance in urination and enemas must be given to guard against other complications.

Careful study may eventually show that several nervous disorders in the larger domestic animals may be associated with this condition.

IMPROVEMENT OF THE SOLUTION OF CALCIUM BOROGLUCONATE FOR SUBCUTANEOUS INJECTION

By L. SEEKLES and E. HAVINGA

Norsk Veterinær-Tidsskrift, 11, 1946, 433-445.

THE authors show that solutions of sodium-calcium borogluconate of a pH about 7.2 being adapted to that of the subcutaneous tissue causes less pain and a slighter local reaction than did the acid solution. The pH of the latter is in the region of 4 and so differs considerably from that of the subcutis.

They give a simple method of preparing the improved solution which has been used in the clinics of the Veterinary Faculty of Utrecht on about 60 animals and never caused reason for any complaint.

Take 62 g. of calcium gluconate with 12 g. of boric acid and boil in 300 c.c. of distilled water until clear. This takes 10 minutes. Allow the solution to cool, then add 14 g. of sodium bicarbonate and boil until development of CO_2 is finished. Allow to cool, then add distilled water up to 400 c.c. Then filter through a hard filter.

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It is claimed that the pH of the resulting solution always lies in the immediate proximity of the neutral point, i.e., pH 7.

Finally, the liquid is sterilised by heating filled bottles in a water bath for one hour at 100° C.

It is recommended that this process be repeated the next day.

It appears that on account of the solution being heated for a long time in bottles of ordinary glass the pH rises 0.1 to 0.2. The pH of the liquid injected therefore ranges 7.2 to 7.3.

REVIEWS

SOME RECENT ADVANCES IN VETERINARY SCIENCE

Issued by the National Veterinary Medical Association of Great Britain and Ireland, to members of the Association, November, 1946

VETERINARY SCIENCE, like other things, forges ahead as its workers reveal more and more that was previously unknown and introduce new methods and techniques. Knowledge was never static, it was ever a growing thing, but of recent years the tempo has been so greatly accentuated that we have been literally flooded by papers, etc., indicating new discoveries in all spheres of Veterinary endeavour.

The ordinary man and, indeed, the specialist cannot deal with or assimilate one tithe of the spate of literature which now rolls forth. The time has arrived when we must look to those who are authorities in their own particular sphere to so condense things that the important and salient features of their particular line of thought and work may be made reasonably available to others not so specialised and to those who would make use of all these valuable things in the field.

In 1943 the N.V.M.A., realising the necessity of such a feature, issued a series of reviews dealing with and condensing the information then available on the sulphonamides, tuberculin testing, mastitis and several other subjects. These articles were published in the *Veterinary Record*.

Now they are able to add to the fount of knowledge, and the present booklet, which we hope will be the first of a series, makes available to the members of the profession a mass of most valuable information on a further series of subjects.

The booklet, in six sections, deals with "Hormone Therapy in the Domestic Animals," "Vitamin Therapy," "Veterinary Radiography," "The Sulphonamides," "The Mechanical Aspects of Digestion in the Ruminant," and "Recent Advances in the Chemotherapy of Protozoan and Rickettsial Infections of Animals."

Each article is from the pen of a recognised authority in his own particular sphere. The N.V.M.A. is to be commended and congratulated on their effort, and we are certain the booklet will be welcomed by specialist, practitioner and above all by the student preparing for his or her professional examinations.

Veterinary Pathology and Bacteriology. GAIGER & DAVIES. Third Edition, by GWILYM O. DAVIES, D.V.Sc., M.R.C.V.S., D.V.H. Bailliére, Tindall and Cox, 7/8, Henrietta Street, Covent Garden, W.C.2. Pp. xii-796, 403 figs.: 30s., post 9d.

WHEN first issued in 1932 this book filled a great gap, for previous to that time, with the exception of manuscript copies of the lectures of Sir John Macfadyean, there was no authoritative treatise on the above subjects within the bounds of a reasonable-sized book such as would be valuable to a student proceeding to his examination. The veterinary student of those days had to have recourse to text-books written especially for the students of human medicine, and these were in no wise adequate, for although basically pathological problems are much the same, there are many specialised aspects to the study of veterinary pathology.

As is often the case with a successful first edition, subsequent editions tend to increase in size, and they begin to resemble the classics which one should keep for reference on the library shelf. This is said, indeed, not in criticism of the present edition, for a perusal of its pages fails to discover any single item which could with convenience be left out. Indeed, one regrets that such things as the vitamins and their associated troubles have not received more notice, especially as nutritional problems are daily becoming more pressing.

In style the author follows the old, well-established plan. Part I deals with degenerations and infiltrations, disturbance of circulation, inflammation and tumours. Part III, specific pathology, would, we think, have been in a more appropriate position if it had been placed in the position of Part II, for general pathology and special pathology form the very backbone of the whole subject, and unless the student is well versed in these two sections there is much in the study of specific disease that he will be unable to comprehend with any degree of ease.

Part II is in reality a treatise on bacteriology, protozoology and virus diseases, and although it occupies the major portion of the book, we doubt if such a succinct account can be found in such short compass in any other tome.

An appendix is included, dealing with post-mortem methods, collection of material and all the many and varied exercises which *in toto* can be summarised as laboratory technique. This is a very valuable chapter, for it will be of the greatest use to the amateur pathologist, and at the same time serve as a valuable reference even to the expert.

We welcome this edition, and say that it should be in the hands of all who wish to keep "au fait" with the advances in veterinary pathology.

To the author we would say, as future editions become necessary, don't forget that the book is primarily one for the student and practitioner who have neither the time nor the expert knowledge to assimilate the classical technical books.

The publishers are to be congratulated, for in spite of the restrictions which thwart the printing trade, they have been able to publish on good paper, and reproduce the 403 figures in an elegant manner.

The Irish Veterinary Journal. Vol. 1, November, 1946, No. 1. Journal of the Veterinary Association of Ireland, 31, Westmoreland Street, Dublin. Price 2s.

THERE have been rumours from time to time that our Irish colleagues contemplated entering the publishing business with a journal of their very own. Rumour has now been translated into fact, and we have in our hands Vol. 1, No. 1, of *The Irish Veterinary Journal,* and dated November, 1946. The journal is the official organ of the Veterinary Medical Association of Ireland, and will circulate quarterly among the members. It is launched with a message, wishing every success, from the Minister of Agriculture, who seems to be aware of the value of the veterinary effort in the economic and scientific life of his country. The need for such a medium as the journal is expressed by Mr. John A. Flynn, the President of the V.M.A. of Ireland, in a message to the profession which immediately follows that of the Minister. Paying a grateful tribute to the *Veterinary Record,* Mr. Flynn states that the *Record* circulates among not more than 25 per cent. of the members in Eire, and, consequently, does not meet their requirements.

In the editorial column the history of the venture is traced, and it is good to note that the Irish students are to play their part in production. This is all to the good, for the students of to-day are the graduates of to-morrow, and if their interest is sustained then there can be no fears for the future. News of the association activities will have prior claim to publication, and with such a constant source of fodder, editorial anxieties will be greatly eased.

In the body of the journal there are articles from the pens of President Flynn and Professor O'Dea. President Flynn's article is the presidential address which he delivered at the annual general meeting in January, 1946. It deals largely with the reorganisation of the profession as envisaged in the report of the Committee of Inquiry on Post-Emergency Agricultural Policy. It is interesting to note that they have planning committees in Eire, just as we do in this country, and also that they appear to follow the example set here, for the committee was composed entirely of non-veterinarians. Professor O'Dea takes veterinary ethics as his theme, and we can commend this article to veterinary surgeons in all parts of the world.

In a report on the activities of the Munster Association, it is pleasing to note that any differences between that association and their Dublin friends are now settled, and the Veterinary Medical Association of Ireland can now speak for a united profession. Parliamentary, and Veterinary Council of Ireland news, notes on veterinary law, a students' section, academic notes, abstracts and a personal section complete a very attractive first issue, and we have no doubt that if this initial standard is sustained the journal is assured of a successful future.

As one would expect of an Irish journal, a little humour is interspaced between the more sonorous items, and "Checkmate," on page 30, is a jewel of Irish wit and resource.

Publishers' Notices

Copy of advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 1st of the month, if proof is required.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

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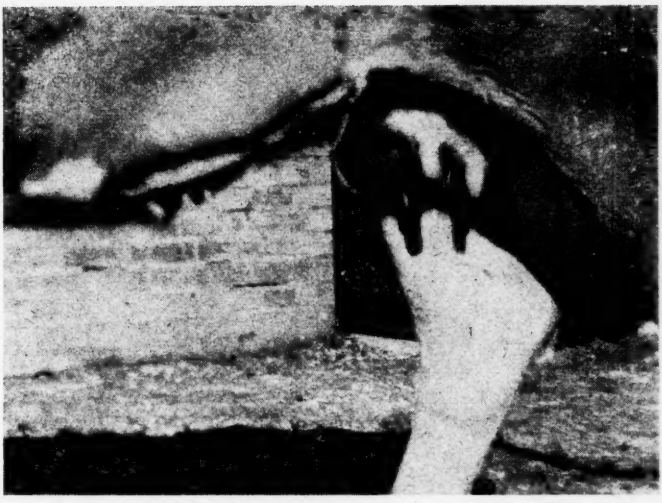
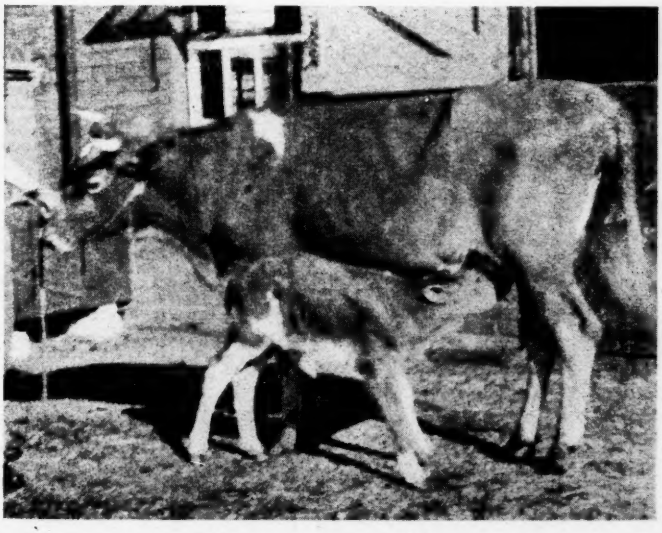


Photograph showing incision 10 days after operation.



Photograph of "Normandy Belle" and calf 10 days after operation.

(*See article by Peter Kiddle and E. W. Jones; p. 20, Vol. 103, No. 1.*)

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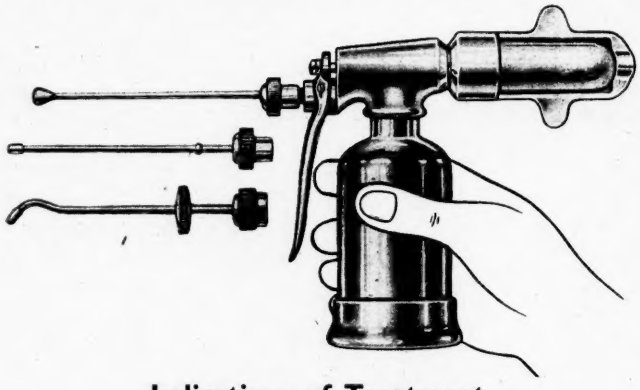

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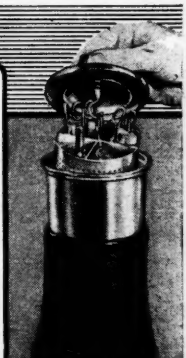

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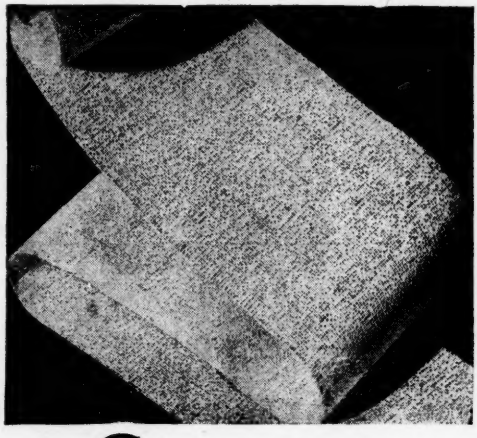

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